FREE POSTER INSIDE! ■ 60 WAYS TO LEAVE THE PLANET

FINAL FRONTIER

The Magazine of Space Exploration

May/June 1990

BEYOND 2001

Somewhere on the boundary of science and sci-fi lies the space program of the 21st century.

Exclusive!

Astronaut Pinky Nelson test drives the Soviet space bike



SPECIAL PRICE

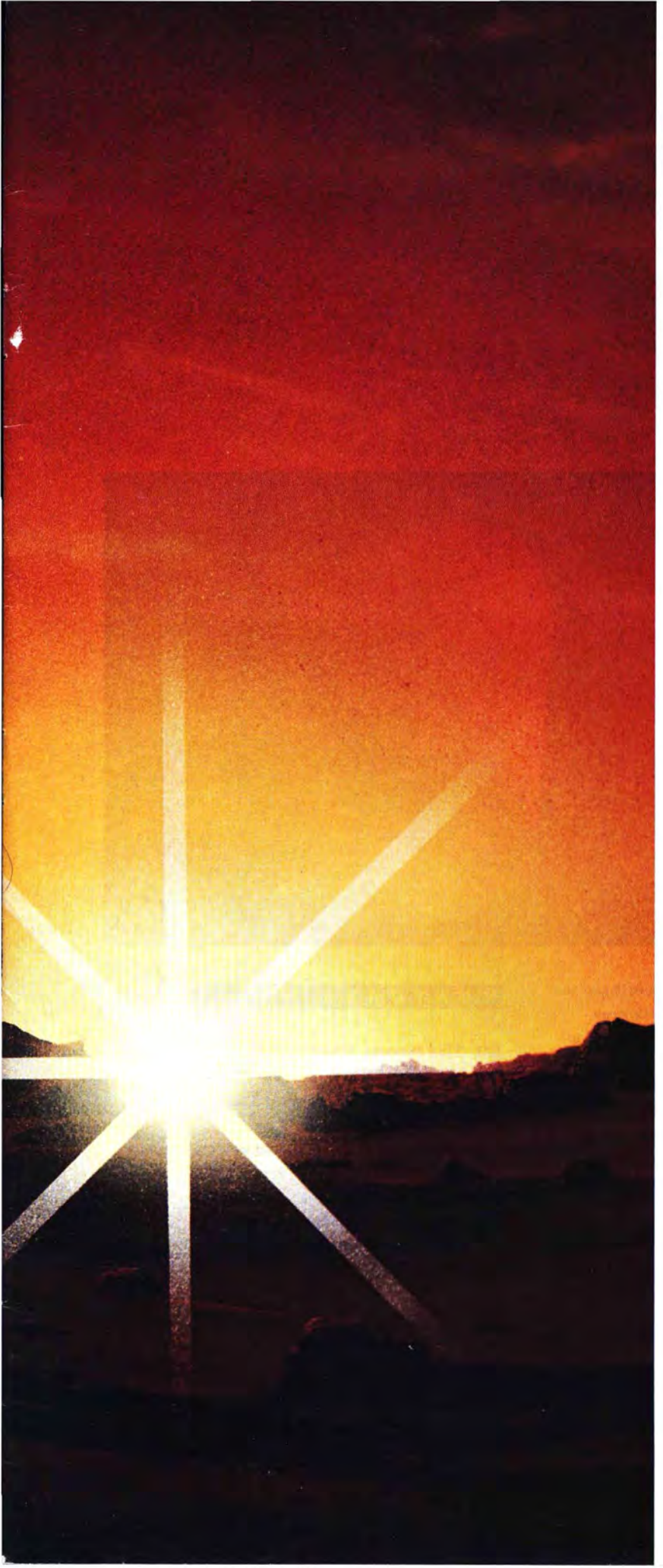
USA $2.95/OTHER $3.95

06

0 14302 73813 4

DISPLAY UNTIL 6/30/90


NASA



LET'S GO BACK FOR THE FUTURE

When the first human sets foot on Mars early next century, Honeywell will be there. For over thirty years, Honeywell has applied control technologies to space.

Control is Honeywell's business. For over 100 years Honeywell's control technology has brought comfort to homes and productivity to workplaces. Today, here on earth, Honeywell is the recognized leader in automation and control.

In space, Honeywell is applying that leadership to such key programs as Space Station Freedom, National Aero Space Plane, Magellan, Galileo and the Hubble Space Telescope... and beyond to proposed lunar settlements and manned Martian missions.

From the Earth to the moon... and on to Mars. Honeywell was there from the start and is ready to return.

For information on Honeywell's control technology, contact Honeywell Inc., Space Systems Group, 13350 U.S. Highway 19 South, Clearwater, Florida 34624 (813) 539-3800.

Honeywell

HELPING YOU CONTROL YOUR WORLD

Contents

May/June 1990

Volume 3, Number 3

DEPARTMENTS

6 From the Publisher

8 Letters

10 The Observatory
A joint mission to Mars
By Yuri Semenov

12 Notes From Earth
Israel's space pioneers, new Venus pictures and more

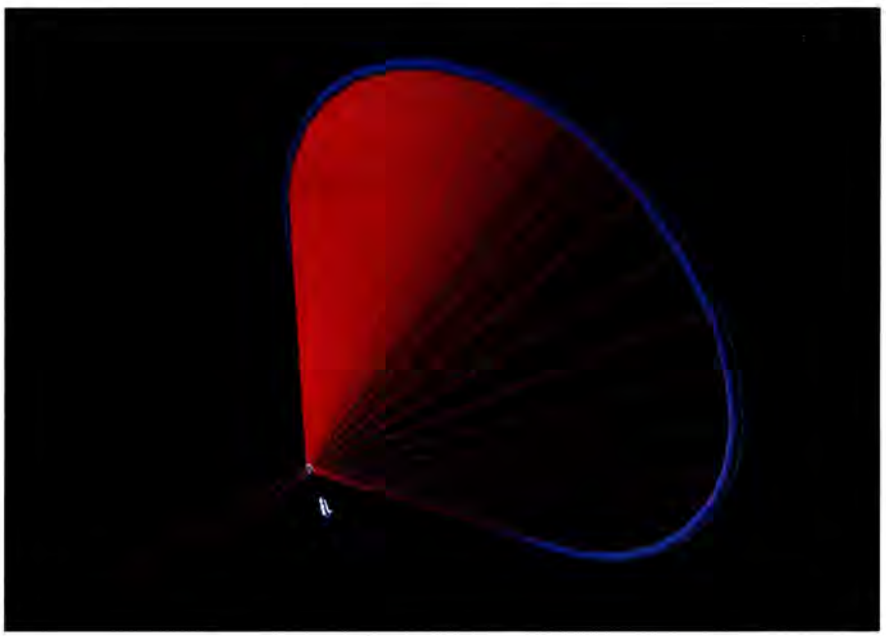
16 Reviews
Space software roundup

16A Mission File: STS-36
Atlantis lights up the East Coast

56 Global Currents
Japan's space hotel
By Alan Ladwig

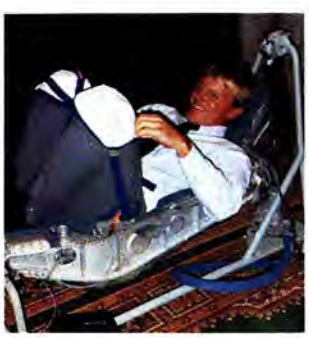
64 Destinations

FINAL FRONTIER (ISSN 0899-461) is published bimonthly by Final Frontier Publishing Company, 2400 Foshay Tower, Minneapolis, MN 55402. Copyright © 1990 by Final Frontier Publishing Company. All rights reserved. Second class postage paid at Minneapolis, MN and additional mailing office. Subscriptions in the U.S.A., its territories and possessions. $17.95 for the year (6 issues). Canada add $5 for postage. Other countries add $9 for postage. POSTMASTER; Send address changes to FINAL FRONTIER, P.O. Box 3803, Escondido, CA 92025. Printed in the U.S.A. Mailed at Minneapolis, Minnesota and additional entry points. Certain editions may contain pages 16A & B and 48A & B. All art and photos courtesy of NASA unless otherwise credited.



page 42

On the cover: Mars is just the beginning. The stars are closer than we think. But to get there, we'll need new ideas. See the stories on pages 24 and 42. (Painting of interstellar vehicle leaving Earth by Houston-area aerospace artist Doug McLeod).



page 46

FEATURES

20 The Wrong Stuff
The women we left behind
By Lillian Kozloski and Maura J. Mackowski

24 Notes From the Radical Fringe
A sketch book for a new century

36 Onboard Freedom: Part Two
Living and working 250 miles up
By Chip Walter

42 60 Ways to Leave Your Planet
Rockets aren't the only way
By W. Dan Leonard

46 An Astronaut in Baikonur
West meets East
By George D. "Pinky" Nelson



Training The Future. We're Doing It.

Gemini . . . Apollo . . . Skylab . . . Shuttle . . . Spacelab . . . Space Station . . . SDI . . . and on to Mars . . . Link Flight Simulation is the training systems leader in the exploration of space.

We've developed all of NASA's manned mission simulators for the past three decades, and recently Link was competitively awarded the Training Systems Contract (TSC) in support of the Johnson Space Center mission to the year 2000 and beyond.

Link's TSC role includes upgrades to the Shuttle Mission Training Facility in Houston, developing training facilities for the Space Station *Freedom*, and evolving the training system infrastructure to meet space exploration requirements of the 21st Century.





Link is also providing systems engineering and development engineering at the National Test Facility, Falcon Air Force Station, Colorado Springs, and other locations as part of Martin Marietta's SDI/National Test Bed team. The National Test Bed has been called "one of the most elaborate computer simulation networks ever developed."

Link Flight Simulation Division
CAE-Link Corporation
a CAE Industries Ltd company
2224 Bay Area Boulevard
Houston, Texas 77058
Phone: (713) 280-4001

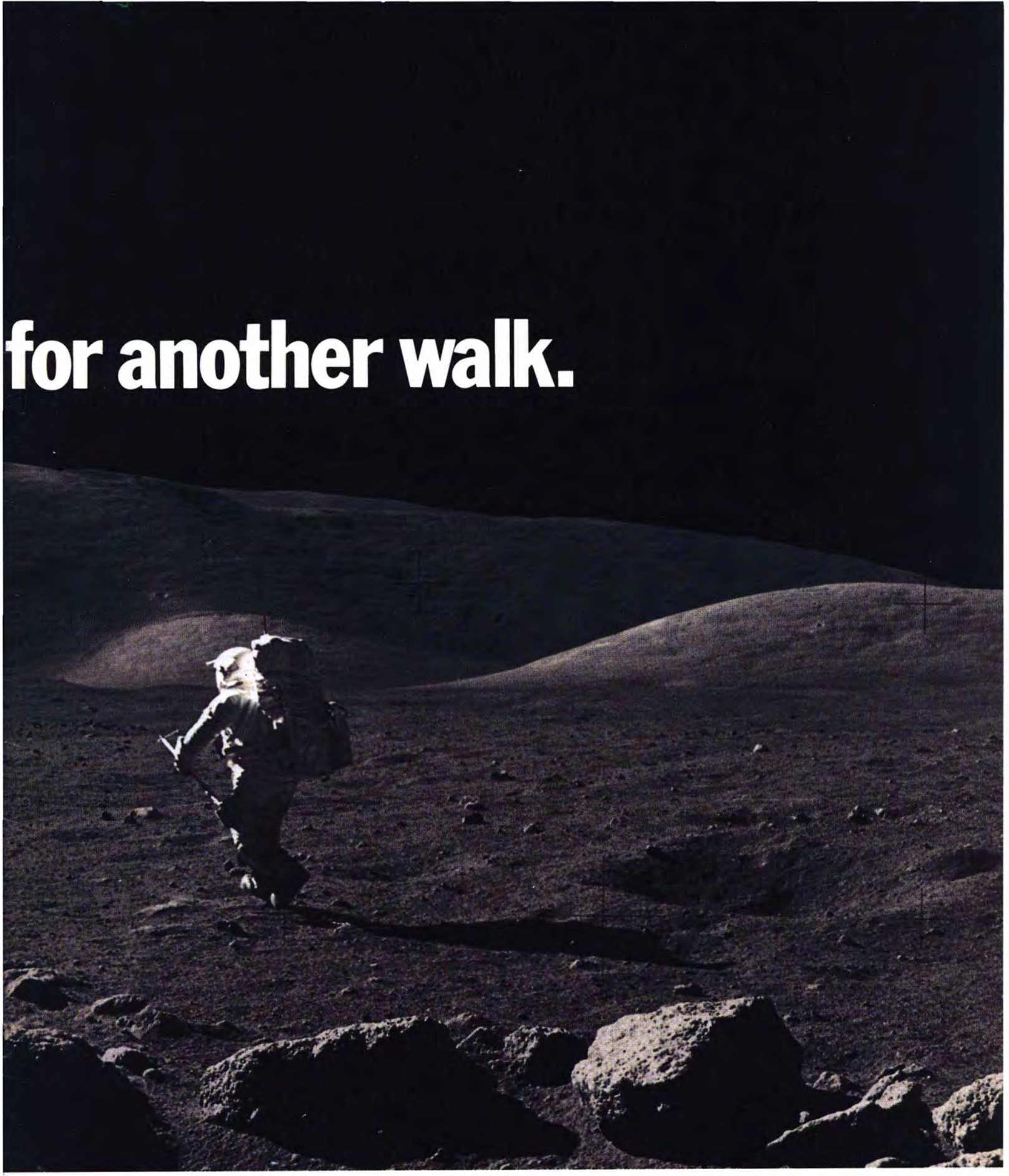
Link

Copyright 1990 CAE-Link Corporation



On July 20, 1989, President Bush launched a new era in space. The Human Exploration Initiative will return America to the moon. And from there, mankind

for another walk.



will take another giant leap — to Mars. It's time to continue the journey we began 25 years ago. It's time to dream. Again.

GENERAL DYNAMICS
Space Systems Division

From the Publisher

Empty space is like a kingdom, and heaven and earth no more than a single individual in that kingdom....How unreasonable it would be to suppose that besides the heaven and earth which we can see there are no other heavens and no other earths.
—Teng Mu, 13th century

There's a moment in my life that I'll always remember. A buddy and I were standing out in the California desert, looking up at the stars. If you've ever been out in the middle of nowhere and looked up on a clear night, you know what I'm talking about.

For the first time, really, I was struck with the vastness of it all, and it led me to much the same conclusion that Teng Mu had reached 700 years earlier. (It's nice to know that at least once in my life I was thinking on the same plane as a great philosopher.)

It was right about that same time that my buddy and I got serious about the wild idea we'd had of starting up a space magazine. We were full of adventurous thoughts, including one that had occurred to many a naive dreamer before us: There's got to be a way to reach those stars. Not being engineers or politicians, we figured our contribution would be a publication that would give full voice to the visionaries of space exploration, and that might help inspire someone, somewhere, to start building our ladder to the stars.

It didn't take long to be brought back down to the realities of modern space travel. Chemical rockets—the same vehicles that put Sputnik and John Glenn in orbit three decades ago—are still the cutting edge of workable technology. Economics and politics still rule, and last I checked, "warp drives" have yet to pass proof of concept.

That shouldn't stop us from dreaming, though. In our "Notes from the Radical Fringe" (page 24) you'll find several individuals who may already be painting the landscape of our future in space. They have the ambition, the imagination, the guts, to look ahead.

I admire them. I know the ridicule they must face. It comes with the territory of being a thinker on the radical fringe. I imagine that the people on the vanguard of space technology back in the '50s, who were saying with complete certainty that we'd land a man on the Moon within a decade, were looked at with a great deal of skepticism, or flat out laughed at.

Some are still laughing today. In 1990, the visionaries have their sights set on Mars. Many think that President Bush might be a bit too ambitious with his talk of lunar bases and expeditions to other planets.

I don't.

But let's say those plans come together. Somehow we conquer all the technological and economic barriers, and in the year 2015 or thereabouts, the moment of glory arrives. Humanity's first footprints on Mars.

If that is the end of road, I think we will have failed.

But if that occasion is our first step to reaching the stars, the start of the *real* space program for future generations, it will be one of the greatest accomplishments of all time.

I only hope that the ideas put forth in this issue, whether they come to fruition or not, serve as an inspiration to the space industry and to the other powers that be to keep looking toward the far future.

And deep in our daydreaming, you never know, we might solve some of the problems of today.

Ever upward,

William Rooney

William Rooney
Publisher

FINAL FRONTIER
THE MAGAZINE OF SPACE EXPLORATION

EDITOR
Tony Reichhardt

MANAGING EDITOR
Jeremiah Creedon

CONTRIBUTING EDITORS
Beth Dickey
Melinda Gipson
Alan Ladwig
Robert M. Powers

CONTRIBUTING PHOTOGRAPHERS
Tom Usciak
Mark Usciak

ART DIRECTOR
Alicia Nammacher

ART ASSISTANT
Julie Eggen

ART PRODUCTION
Tom Fisher

TYPESETTING
TypeMasters/TypeShooters

ASSOCIATE PUBLISHER
Carey Bohn
(612) 332-2748

ADVERTISING AND PRODUCT SALES
Stephen Martin
(612) 332-3208

WESTERN REGIONAL MANAGER
Robert J. Rielly
(818) 843-5150

CIRCULATION DIRECTOR
Rebecca Sterner

CIRCULATION MANAGER
Mary K. Welch

PRESIDENT AND PUBLISHER
William Rooney

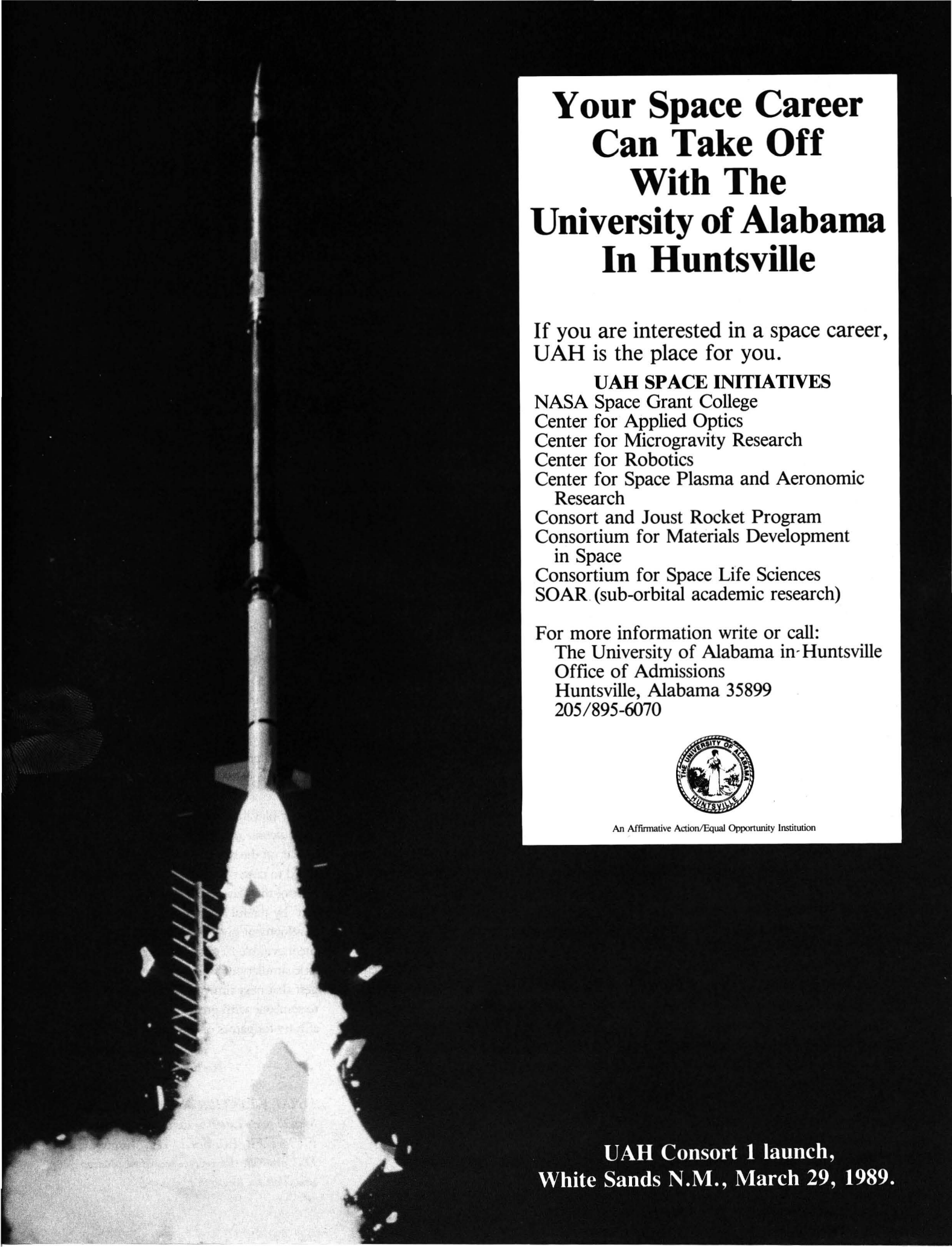
PUBLISHER'S ASSISTANT
Kirby Jones

ADMINISTRATIVE ASSISTANT
Karen Hauser

SUBSCRIPTION SERVICE: Mail all subscription orders, changes of address (include latest label or give both old and new address) and other subscription correspondence to: FINAL FRONTIER, P.O. Box 534 Mt. Morris, IL 61054-7852 (815)734-6309.

PUBLISHING AND PRODUCTION OFFICE: FINAL FRONTIER, 2400 Foshay Tower, Minneapolis, MN 55402 (612) 332-3001. President: William Rooney. Founder: Robert Welch. Chairman and Chief Financial Officer: Robert Carroll.

EDITORIAL CORRESPONDENCE: Send submissions c/o the Editor, FINAL FRONTIER, P.O. Box 11519, Washington, D.C. 20008. We cannot be responsible for unsolicited material or photos. Article submissions must be accompanied by a self-addressed, stamped envelope. Opinions expressed in articles are those of the authors, and not necessarily of FINAL FRONTIER.



Your Space Career Can Take Off With The University of Alabama In Huntsville

If you are interested in a space career, UAH is the place for you.

UAH SPACE INITIATIVES

NASA Space Grant College
Center for Applied Optics
Center for Microgravity Research
Center for Robotics
Center for Space Plasma and Aeronomic Research
Consort and Joust Rocket Program
Consortium for Materials Development in Space
Consortium for Space Life Sciences
SOAR (sub-orbital academic research)

For more information write or call:
The University of Alabama in Huntsville
Office of Admissions
Huntsville, Alabama 35899
205/895-6070

An Affirmative Action/Equal Opportunity Institution

UAH Consort 1 launch, White Sands N.M., March 29, 1989.

Letters



Hammering Thor

I agree with Thor Heyerdahl ("The Observatory," March/April 1990) that in our hurry to explore and colonize space we shouldn't forget how precious Earth is. But where does he get the idea we space advocates are only interested in living in "chromed paradise platforms?" Hasn't he read about the efforts to create Earthlike habitats in space, as reported in *Final Frontier* and elsewhere?

One motto of the space movement is, "Preserve Earth—Colonize Space." This concept demands three things from those who want to move into space. First, we must learn as much about Earth as we can so that we know how to preserve her. Second, we must reach and use the vast resources of the Solar System so as to remove the need for Earth to provide them. Third, we must encourage a two-way flow of people and knowledge lest we indeed, as Heyerdahl writes, "cut off the branch we sit on."

Perhaps Mr. Heyerdahl should pay more attention to the many articles and books about space settlement. His ignorance of the value and philosophy of the space movement is showing.

Theresa Holmes
Front Range L-5 Chapter, National Space Society
Greeley, Colorado

I am one of the space-advocating "optimists" Mr. Heyerdahl derides, but contrary to his assumptions I have no love for chrome, sterile soil, plastic flowers or orbiting Shangri-las. The environs of Terra are too ingrained in us to sacrifice them for such stark utilitarian nonsense.

Nor do I have any hate for the planet Earth. Our planet should be returned to, and kept in, top natural condition for the last billion years or so of its existence (I'm optimistic enough to think that Homo sapiens, or more likely our successors, may be around after our world has succumbed to age).

And yet I share Arthur C. Clarke's view on the issue as he presents it in *The Promise of Space:* "The challenge of the great spaces between the worlds is a stupendous one; but if we fail to meet it, the story of our race will be drawing to a close. Humanity will have turned its back upon the still untrodden heights and will be descending the long slope that stretches across a thousand million years of time, down to the shores of the primeval sea."

John M. Mulhern
Pawtucket, Rhode Island

There is a major fallacy in Thor Heyerdahl's view that cities in space could never be more than glorified oil platforms, and the fallacy comes out of Heyerdahl's assumption that the other planets are "obviously uninhabitable for human beings." Although no other planet has an ecosystem like Earth's, there are plenty of resources on other planets, moons and asteroids from which to build a technological civilization.

Much will have to be brought from Earth: seeds, bacteria, earthworms, livestock (or embryos) and people. But much is to be found in space: water, methane, organic compounds, lunar soil as fertile as volcanic ash, metals, transuranic elements, constant solar energy, even oxygen in plentiful supply. Most of all, there is space out in space, room to expand. As a person committed to emigration from Earth, I don't expect to wind up in "cramped quarters" or to "regret the money and efforts wasted to be exiled in outer space." Living in space will be challenging and enjoyable, much like it is on Earth.

James E. Davidson
Director for Region 3, National Space Society
Friendswood, Texas

Soviet Woes

Trouble in Star City" (January/February 1990) was interesting and informative, but one has to wonder if Star City's troubles are all that recent.

For example, the 1981 edition of *The Illustrated Encyclopedia of Space Technology* mentioned reports that a large, 12-person space station might be launched by the Soviets by 1985, and that they would unveil a fly-back booster by the end of the decade. What happened to these space vehicles? If it turns out they weren't built for lack of funding, then the Soviet space program was having budgetary problems long before the public dissent became known.

Michael J. Gallagher
Cortland, New York

Superficial

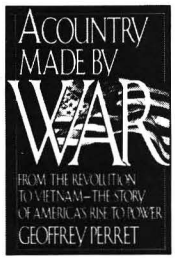
I found your review of the innovative space exploration board game *Liftoff!* (January/February 1990) superficial and somewhat snide. I have played the game several times and found it well researched, well paced and eminently playable. You stated correctly that the outcome of a mission depends to some extent on the result of a die roll, but you failed to note the exceptional degree of control the player can exert upon that result by careful allocation of research and development budgets. *Liftoff!* integrates the inevitable factors of chance into a realistic simulation of historical reality. I suggest that next time you assign your review to someone with greater experience in and affinity for games of this type.

Charles Bell
North Hollywood, California

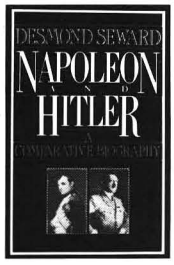
FINAL FRONTIER welcomes your letters. Send them c/o Letters to the Editor, FINAL FRONTIER, P.O. Box 11519, Washington, D.C. 20008. Please type your correspondence and limit the length to 150 words.

TAKE ANY 3 FOR $1 EACH

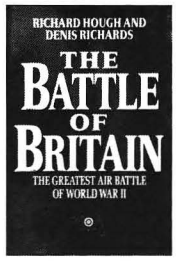
Plus a 4th at the low Members' Price. **NO RISK, NO COMMITMENT.**



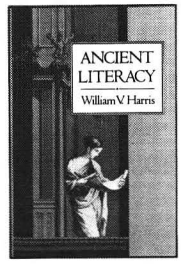
1719. $22.50/**$17.95**



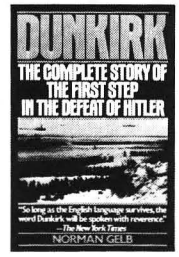
1891. $19.95/**$14.95**



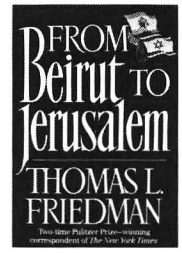
2386. $27.50/**$21.50**



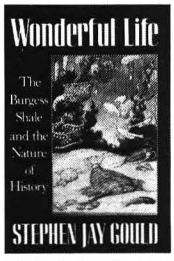
2725. $35/**$24.95**



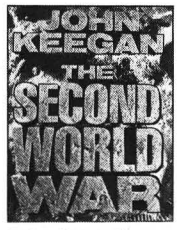
2477. $22.95/**$17.50**



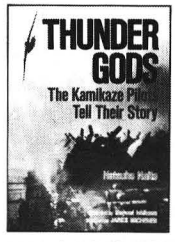
1925. $22.95/**$17.50**



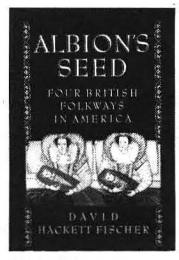
2709. $19.95/**$16.95**



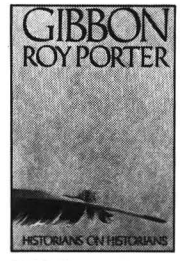
3434. $29.95/**$23.50**



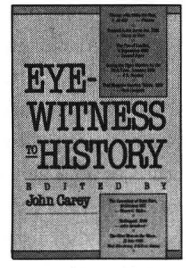
2220. $18.95/**$16.50**



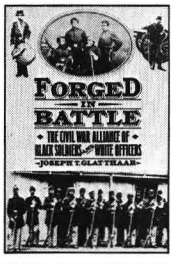
2857. $39.95/**$22.95**



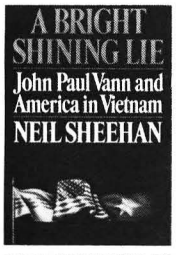
2022. $24.95/**$18.95**



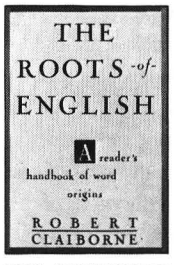
6007. $24.95/**$17.95**



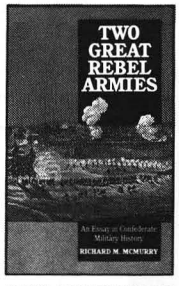
2816. $24.95/**$18.95**



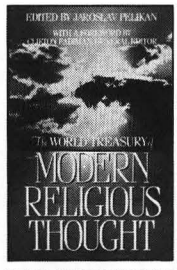
1495. $24.95/**$18.50**



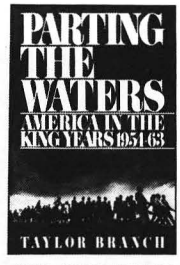
1933. $18.95/**$15.95**



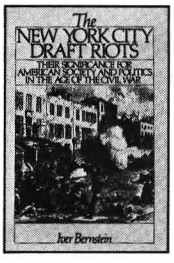
9282. $22.50/**$17.50**



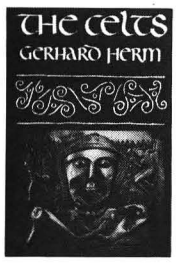
3590. $29.95/**$23.95**



1081. $24.95/**$18.95**



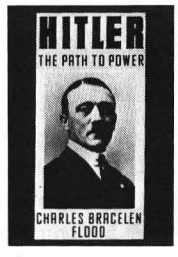
2766. $29.95/**$21.95**



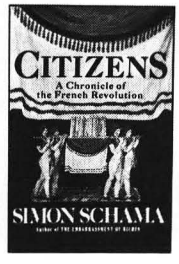
1859. $15/**$10.50**



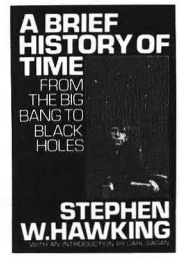
1792. $22.95/**$18.50**



1701. $24.95/**$18.95**



1396. $29.95/**$21.95**



3087. $18.95/**$16.50**

Save on the best recent history titles.

(First price is publisher's list. **Boldface** is Members' Price.)

No matter what area of history you enjoy reading about most, you'll find that History Book Club offers some of the finest selections being published today. And no book club we know offers greater savings–as much as 30% off publishers' list prices.

You can save even more by taking advantage of our Introductory Offer. Select any three books on this page for $1 each when you take a fourth book at the low Members' Price–plus shipping and handling. Thereafter, you're not obligated to order any more books. You may cancel membership at any time by notifying History Book Club. We may cancel your membership if you elect not to buy at least one book in any six-month period.

How the Club works. You'll be able to choose from 150 to 200 books featured each month. History Book Club always offers its members well-made, long-lasting editions.

You'll receive our *Review* and a dated Reply Form 14 times a year (about every 4 weeks), plus up to 4 more offers of special selections. If you want the "Editors' Choice," do nothing–the book will come automatically. If you want another book, or no books at all, return the Reply Form by the date specified. A shipping and handling charge is added to each shipment.

Your HBC guarantee: If you receive an unwanted "Editors' Choice" because you had less than 10 days to decide, simply return it and pay nothing.

History Book Club®
Camp Hill, PA 17012-8805

Please enroll me in History Book Club according to the no-risk, no commitment terms outlined in the accompanying ad. Send me the four books whose numbers I have listed below. Bill me $1 each for the 3 choices on the left, and the fourth at the low Members' Price–plus shipping and handling.

H727-5-0

0-13

Name_____
(Please print clearly.)

Address_____ Apt. #_____

City_____ State_____ Zip_____

All orders subject to approval. Prices generally higher in Canada.

© 1990 History Book Club, Inc.

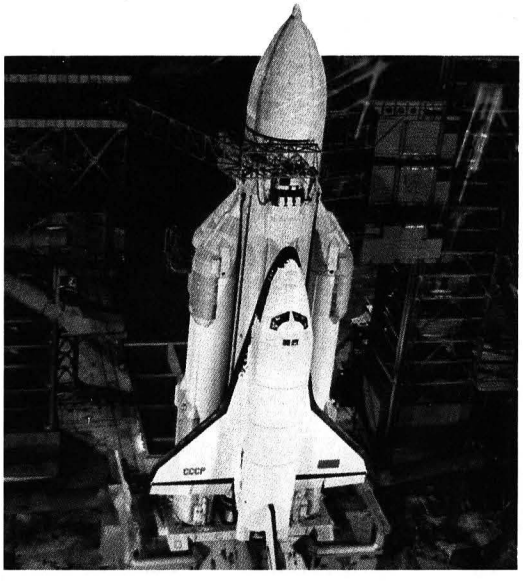
The Observatory

Together to Mars: A Proposal

How a U.S./Soviet mission might work

By Yuri Semenov

The main direction in Soviet cosmonautics today is the development and exploitation of Earth-orbiting stations, and so it will apparently remain in the foreseeable future. Several generations of orbiting stations have been designed over the past years, and they have become an effective instrument for the exploration of near space. The Mir station in operation at the moment is gradually building up its research capabilities by way of specialized modules—proof that space orbiters have a colossal potential. The new Mir 2 orbiter, which is likely to be launched before the end of this century, will have a much higher power capacity compared to the present station. In effect, it will be an orbiting plant.



SPACE COMMERCE CORPORATION

The Energia heavy-lift rocket (shown here with the Buran space shuttle) could get a joint Mars expedition off the ground.

One of the pressing tasks today is the further advancement of the station's re-supply systems. The Buran [space shuttles] open up broad opportunities for delivery to orbit and the return of big payloads. Of course, such ships could service orbiting stations, too, but the costs of cargo delivery using the Buran are still prohibitively high.

The future apparently belongs to aerospace vehicles that use atmospheric oxygen as a fuel component. Estimates show that an aerospace plane can prove more acceptable in terms of cost for attending to the needs of orbiting stations.

It would be expedient to use the experience gained by the Energia Research and Production Association in designing sophisticated manned complexes in tackling major economic problems, as well. One such task is an early establishment of telephone communications throughout the Soviet Union. The country's population is spread quite unevenly over vast territories and distances, which creates problems in the accomplishment of this task. To this day, every third residential community in the USSR has no telephone communications.

Resolving this problem by traditional means and methods would be very difficult. Space technology can cope with this task much faster and at much lower costs. What does this mean? Today, our firm is designing heavy space platforms weighing 18 to 20 tons, which will be put into geostationary orbits by Energia rockets. These platforms can accommodate big automatic telephone exchanges with a capacity of up to 1.5 million channels, and can also be used for multi-channel telecasting, including high-resolution television.

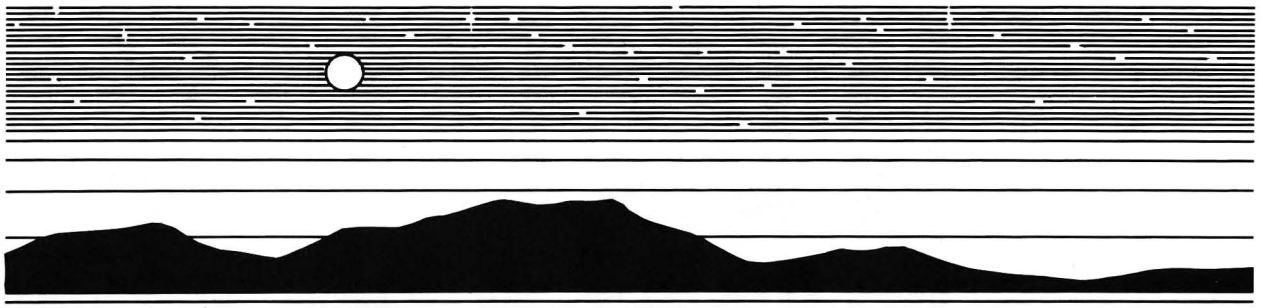
I think that powerful orbiting relay platforms may be of interest not only for the Soviet Union, but for other countries as well. This opens up new prospects for international cooperation in this sphere. The USSR is prepared to establish business contacts with all foreign organizations concerned, naturally including U.S. companies.

And yet, for all the importance of such practical tasks, it would be wrong to forget about fundamental research. I am convinced, for example, that sooner or later people will fly to Mars. So we have no intention of stopping our work in this direction. Our firm is already actively working on a Martian project. A special Energia rocket has been designed and is undergoing flight tests now, which can be used for delivering components of the future Martian ship to orbit. We also have designed an automatic docking system needed for assembly of the ship units in orbit. We have experience in designing Earth-orbiting stations for extended manned missions, which can serve as a prototype of living quarters for an interplanetary ship.

We also have experience in accomplishing manned missions lasting up to a year and longer. Finally, we have already designed electro-jet engines with

continued on page 63

Yuri Semenov is the General Designer for the Soviet Union's Energia Research and Production Association.



We Fill in the Space Above . . .

Your Aerospace Museum at the California Museum of Science and Industry houses one of the finest aerospace science collections found anywhere. The aircraft, spacecraft, and interactive exhibits demonstrate the dreams and visions of the men and women who have made Southern California the aerospace center of the world.

The dedication and integrity of these men and women have made the United States aerospace industry a national resource. Their contributions improve our quality of life, advance our scientific knowledge, and help defend our precious freedoms. Today's achievements are only the beginnings of discoveries yet to come.

We invite you to join us by becoming a member of the Aerospace Affiliates of the California Museum Foundation. With your help, we can preserve this museum as a center of learning and enjoyment for all those who share the aerospace dream.

The companies listed here support the Aerospace Museum.

Hughes Aircraft Company
Litton Industries
Northrop Corporation
Rockwell International
TRW Space & Defense Sector

. . . You Fill in the Space Below

Please send me information about joining the Aerospace Affiliates of the California Museum Foundation

Mail to:
California Museum Foundation
700 State Drive
Los Angeles, CA 90037

Name _____

Address _____

City _____

State _____ Zip Code _____

NOTES FROM EARTH

Promised Land

While Israelis and Palestinians continue their earthbound struggle over an area hardly larger than the state of New Jersey, Jack Adler dreams of a new land of milk and honey—in space.

A retired Honolulu businessman, Adler has for more than a decade been encouraging Israel to look skyward. "My rebbe [rabbi] told me there wouldn't be enough room for all the Jews on Earth, so I want to give half a million dollars to anyone who can put Jews into outer space," Adler said. He then backed his claim with $685,000 worth of securities, helping to establish Israel's Space Technology Fund in 1978.

Since then the Adler Fund for Space has pumped $2 million into Israeli space research. The projects have varied from solar-pumped lasers and optical communications for use in space to photosynthetic reactions in simulated planetary atmospheres and their possible role in the manufacture of oxygen, fuel and food.

What these projects have in common is their pragmatic value for extraterrestrial human settlement—a grant criterion that Adler has been adamant about from the onset. Specifically, he has earmarked his monies to go toward establishing a Jewish colony on the Moon.

When the Israel Space Agency (ISA) was founded in 1983, its Committee for Astronautics encouraged Israeli scientists to submit research proposals to the Adler Fund. ISA chairman Yuval Ne'eman readily agrees that Israel should "be among the pioneers in outer space and take part in its conquest." But he also admits that finding suitable recipients for Adler's largess has not always been easy.

A case in point is the senior Israeli researcher who recently proposed a study of distant galaxies. He was turned down. "I had to explain to him that he was talking of other galaxies," says Ne'eman, "and there is no chance Jews will reach there in the next few million years."

Adler has never wavered in his resolve to see Jews pioneer space settlement, however. To speed things up, he's offering a new personal bonus—$100,000 to each member of the first Jewish family to settle on another planet.

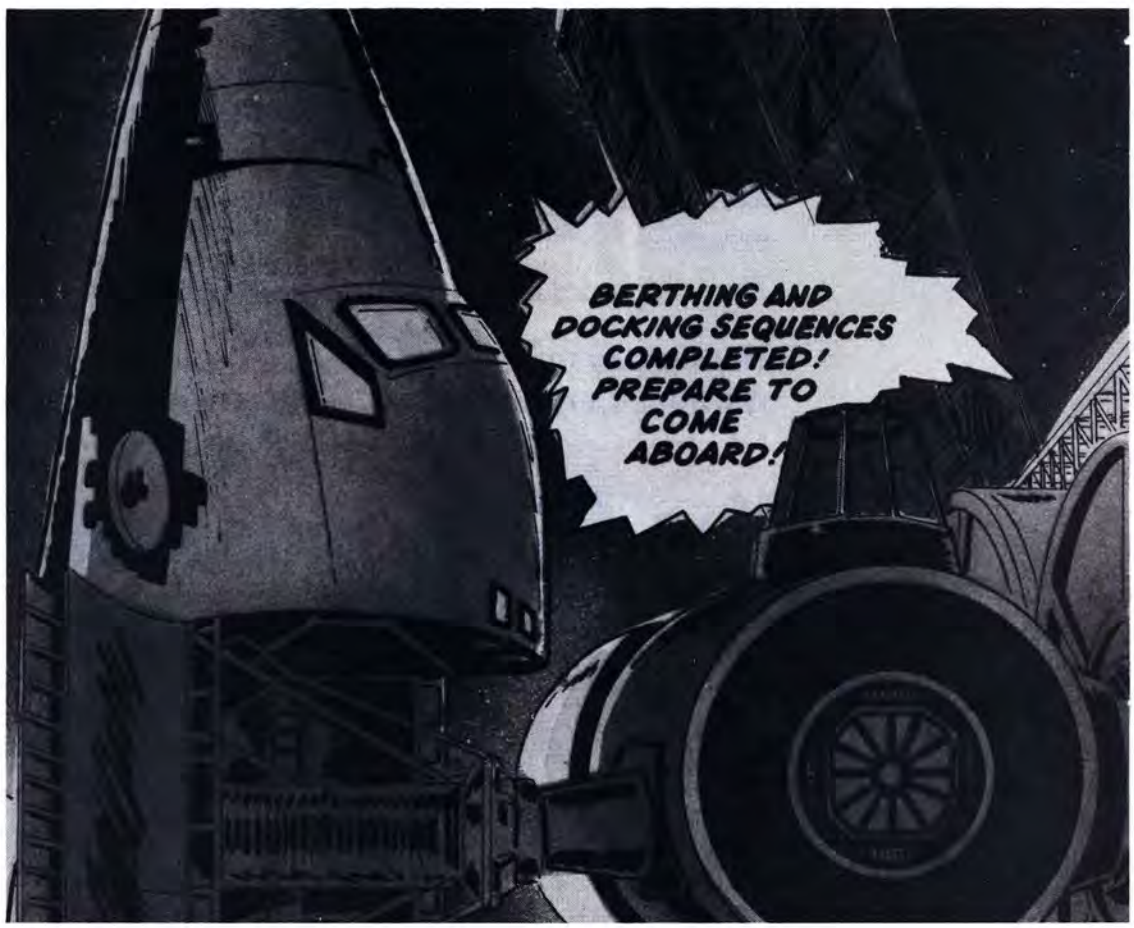
—Mindy Leaf



Space Station Illustrated

Comic books are a sneaky way to teach kids—just ask someone who relied on *Classics Illustrated* to pass English lit.

Or ask Manfred von Ehrenfried, who envisions a similar role for his 20-page color car-



toon strip *Adventures on Space Station Freedom*. So far, though, educators don't seem too interested.

"When I was a kid, we used comic books as a quick study guide," says von Ehrenfried. "Today, there's a stigma on comic books." The fiftysomething former teacher thinks that may explain why his comic book, about four teenagers whose science fair entries win them a week aboard the NASA/international space station, hasn't made it into the hands of many students. Six months after the first edition of 100,000 was published, fewer than half had been distributed.

As a result, he claims, thousands of youngsters are missing out on something that just might spark their interest in scientific careers.

"Uncle Dutch," as he is known in the funny pages, wrote the comic book for youngsters between ages 8 and 14. "Even adults have told me they learned more from that comic book than they have from NASA publications," boasts von Ehrenfried, whose company also publishes information brochures and technical documents for NASA.

Von Ehrenfried invested $60,000 out of his own pocket to publish his work. He saw it as one small way to help solve what experts predict will be a serious shortage of qualified engineers, scientists and mathematicians in the next two decades.

"By the time the space station is in orbit, everybody you've ever heard of from Mercury, Gemini and Apollo will be long gone," he says. "I wanted to use the characters to get kids to think about long-range planning for their careers."

But von Ehrenfried learned that schools consider the comic books either too frivolous or a luxury they can't afford. He also thought aerospace contractors would buy the books, emblazon them with logos and donate them to schools. Only a few did.

For information about *Adventures on Space Station Freedom*, write to von Ehrenfried at Technical & Administrative Services Corporation, 600 Maryland Avenue, S.W., Suite 200 East, Washington, D.C., 20024. The books retail for $1.50 each. The comic book isn't available at newsstands, but it is sold in gift shops at some government space centers.

—Beth Dickey



CUSTOM COMIC SERVICES

Plymouth (Moon) Rock

Since we last checked in with the makers of *Plymouth*, a made-for-TV movie set on a future lunar base (January/February 1990), filming has been completed on the two-hour pilot, which is scheduled (tentatively) to air on ABC television in late May.

The story, which involves a small Oregon community transplanted to the Moon after an industrial accident destroys their town, required the construction of a 1/96 scale "Moonbase" complete with miniature Moon rovers and mining operations in Saugus, California, near the sound stages of Culver City.

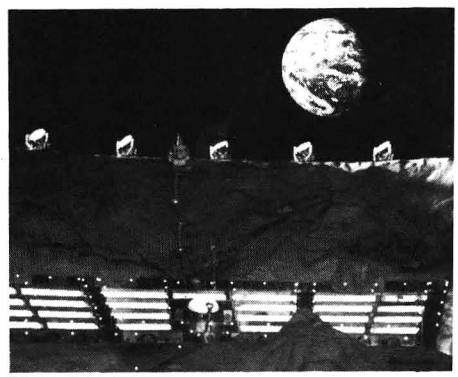
To make sure he got all the technical details right, writer/producer/director Lee David Zlotoff sought advice from NASA experts such as Wendell Mendell and Mark Cintala of the Johnson Space Center, and even went so far as to name his fictional Mayor of Plymouth "Wendell."

In the course of his research, Zlotoff also talked to several of the Apollo astronauts who've been to the Moon, including John Young, Eugene Cernan and Harrison Schmitt. Buzz Aldrin visited the set of *Plymouth* during shooting, and Apollo 12's Pete Conrad "was so tickled by the whole thing," according to Zlotoff, that the producer gave him a bit part in the film, playing himself. It seems the Unidac company, which owns the lunar base, has hired the former astronaut (who walked on the Moon in 1969) as "equipment quartermaster" and resident wise head in charge of spacewalks.

As for *Plymouth's* plot, aside from giving a realistic portrayal of life on a lunar base, it follows the adventures of the town's doctor/mother figure, Addy Mathewson, who worries about being pregnant in 1/6 gravity, about solar flares, about offspring who'd rather be on Earth, and about her rocket jockey boyfriend, who'd rather be building a "Crimson Bridge" to Mars. All everyday concerns, when you live on the Moon.

—Tony Reichhardt

Scenes from *Plymouth*: The lunar base nestled in the perpetual shadows of crater Pythagoras; town doctor Addy Mathewson, sharing a moment with technical engineer Gil Eaton before he heads out for a Moonwalk.





WALT DISNEY COMPANY TELEVISION

Just the Fax

When it works, you love it, and when it doesn't, you hate it, even if you don't let on. The object of those mixed emotions is "the text and graphics system," or TAGS—NASA-speak for a

NOTES FROM EARTH

space shuttle fax machine.

The TAGS, a $200,000 donation from the U.S. Navy, is being flight-tested as a replacement for the old-fashioned teleprinters that NASA uses to send information to orbiting shuttle crews.

Ron Dittemore, a flight director at the Johnson Space Center in Houston, sings its praises: "You just send pictures, photographs and copies instantaneously. The crew can read them very easily, and they love it."

Even when they hate it. Making an off-the-shelf fax work right in microgravity isn't easy, as the dialogue between the astronauts and Mission Control often confirms. The biggest nuisance seems to be getting the paper to lie flat in the tray instead of curling up and jamming the machine.

"We've had more than our fair share of jams, I'll admit that," Dittemore says.

Except for responding to radio transmissions instead of telephone calls, the TAGS works just like a $300 facsimile machine on Earth. Mission controllers have radioed up everything from crossword puzzles and weather maps to maintenance instructions and flight plan changes.

"The machine is an outstanding machine. It really has a good quality," pilot Mike McCulley insisted after testing the TAGS aboard Atlantis last October.

But his frustration with the persnickety fax was evident in a shuttle-to-ground conversation one morning: "I almost hate to start the day talking about TAGS...seems like we've spent a lot of time talking about it," McCulley told Houston at the beginning of a test. "But anyway, the first 8 or 10 pieces of paper are blank and pretty highly curled, almost like we're getting to the end of the roll or something."

Video transmitted from Columbia last January featured mission specialist Marsha Ivins holding a piece of paper folded like an accordion. It had been jammed in the fax. Commander Dan Brandenstein improved the flow by taping two strips of paper, a makeshift guide, to the delivery tray.

Despite its problems, NASA defends the shuttle fax. "Back when it all started, it certainly looked marvelous," says Milt Heflin, another flight director. "Each time we fly it we believe we get a little closer to making it a system that we can rely upon." —*Beth Dickey*

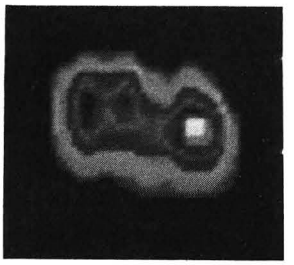


The planet Venus hides behind a dense cloud cover in this photograph returned by the Galileo spacecraft last February. Galileo swung past the planet February 9, taking photos, conducting science observations and picking up speed from Venus' gravity field. The spacecraft is due to pass Earth at close range in December, and will reach its ultimate destination, Jupiter, in 1995. Round spots in the picture are caused by dust on the camera.

Get Your Peanuts!

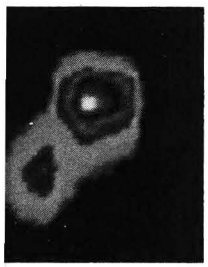
Weird, cratered and exotic, near-Earth asteroids–the ones that whiz across Earth's orbit–have been known on occasion to get a little too close. Yet until recently we'd never had a really good look at one.

Enter a mile-wide chunk of rock known as 1989 PB. First spotted flying toward Earth last August 9 by astronomer Eleanor Helin using the Palomar Observatory, 1989 PB provided Jet Propulsion Laboratory radar expert Steven Ostro a rare opportunity to ply his trade. As the tiny asteroid approached Earth within 2.5 million miles, Ostro zapped it 10 days later with a high-powered radar beam from the 1,000-foot Arecibo radar-radio telescope in Puerto Rico. The changed beam that echoed back startled even the asteroid experts. 1989 PB appeared to be two objects in one.

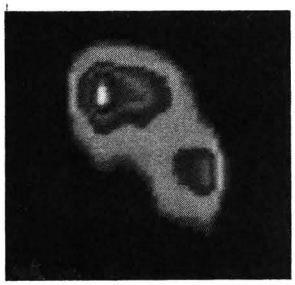


A dumbbell, some called it, a peanut. Ostro, who is assembling an inventory of asteroid shapes, prefers the term "bifurcated." The asteroid, he says, is "like two oranges squashed together" by gravity. While the rest of Ostro's inventory consists of radar images no larger than one picture element ("pixel") across—all showing strange shapes, full of concavities and bizarre irregularities—this

much more revealing image, with two or three dozen pixels for the asteroid, shakes him up. "Are they *all* double objects?" he asks. "Or were we just lucky" enough to focus on a really rare one?

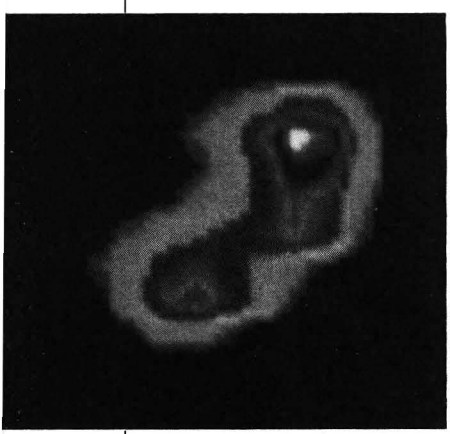


The new data, says Ostro, are a tease. He and his colleagues hope that upgrades to the Arecibo telescope planned for 1993-94 may help uncover more about these free-flying scraps of rock, some 135 of which have been sighted.



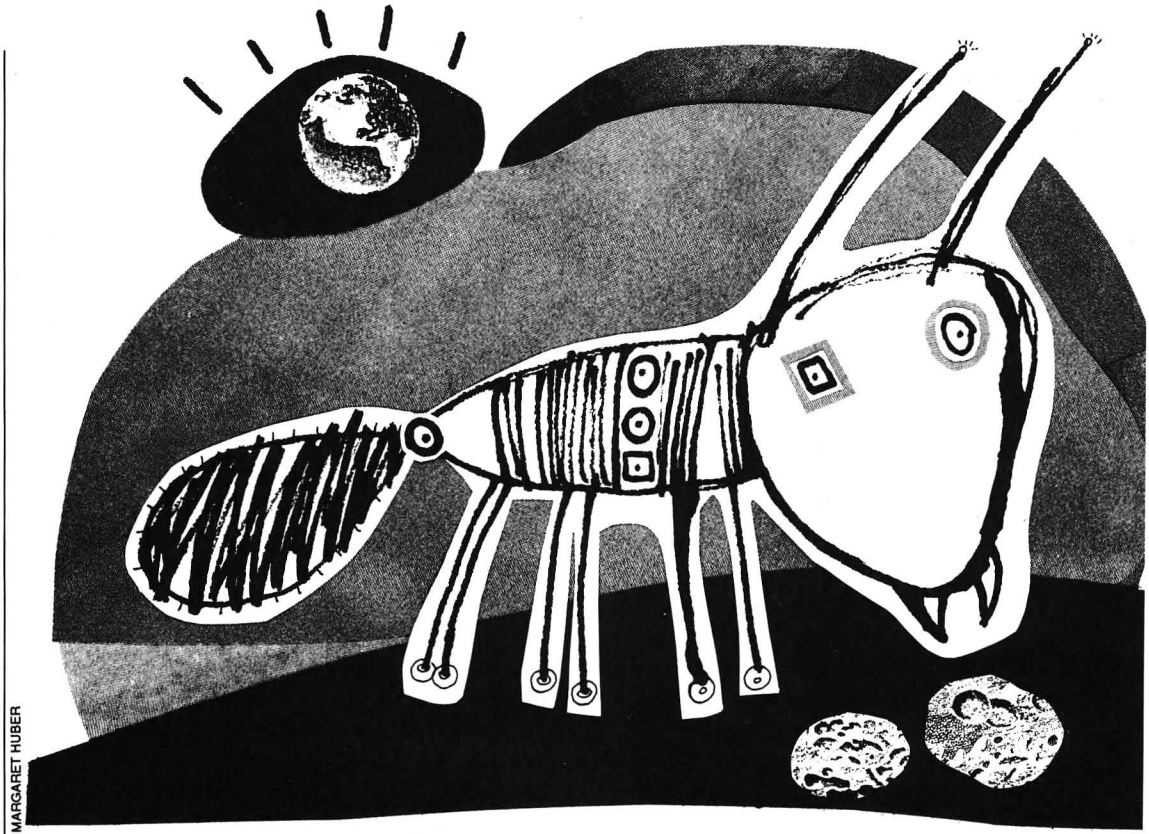
Understanding near-Earth asteroids would have more than casual interest. If little 1989 PB had hit the Earth, says Ostro, it would have released "more energy than exists in all the nuclear and conventional arsenals in the world."

—Ray Spangenburg/Diane Moser



STEVEN OSTRO/JPL

Four views of asteroid 1989 PB: "Like two oranges squashed together."



MARGARET HUBER

Planet of the Ants

It sounds like something out of a campy sci-fi flick: a red planet crawling with giant ants that click their pincers and devour everything in sight.

It's actually one scenario for a "sample return" mission to Mars. In David Miller's imagination, the hungry ants are actually tiny robots that roam the surface and scoop up Martian soil to take home to Earth.

Miller, one of the robotics experts designing NASA's proposed Martian rock hunt, thinks that using 100 toy-sized rovers instead of one huge lander could save the project billions of dollars. A Mars sample return mission could cost even less than the $1.5 billion flight of Galileo to Jupiter, guesses the Caltech computer scientist.

"It should cost well under a billion dollars," Miller figures, "so it's a bargain as far as interplanetary launches go these days."

Miller's idea is still a sketch on the drawing board. But according to his vision, a spacecraft would drop up to 100 mini-rovers into the Martian atmosphere before descending to the surface itself. Protected by heat shields and parachutes, the mini-rovers would hit the ground running—literally.

They would be programmed to gobble up samples until their bellies were full, then home in on a radio beacon aboard their mother ship. "If these guys can make it from wherever they're dropped off back to the return vehicle in a year, you're doing fine," Miller says.

For the idea to work, he figures, each rover would weigh less than 10 pounds and measure no more than 18 inches long. It would be solar-powered and would crawl no faster than one or two inches per second over the surface. With a single square-foot solar array charging its battery, a mini-rover could run at this speed for a few hours, covering a few thousand feet a day.

"My guess is it might look like a giant ant with mandibles in front," Miller says. Each rover would have a vise that could squeeze and crack a rock outcropping, a trap to catch the sample and a camera to photograph where the sample came from.

Miller thinks the scenario is a money-saver because the mini-rovers can widen the scope of a single mission. What's more, they can take a beating better than a sophisticated, large roving lander. "You can basically have the things plow into the Mars surface at 100 miles an hour and use air bags to reduce the shock," Miller says. "If you lose a few, it doesn't really matter."

—Beth Dickey

Reviews

Space Program(s) ■ *By Jay C. Lowndes*

A growing number of home computer programs are designed to convey what astronauts, space entrepreneurs and astronomers see every day on the job. Capitalizing on the allure of space is not a new idea among programmers, but most space-related software in the past has been written by people who learned their craft creating special effects for movies like *Star Wars.* In contrast, those who developed simulation software for actual astronauts put less emphasis on spectacular visuals and more on technical authenticity.

Recently, though, a major new force has begun to influence these products. Contractors who have worked for NASA and the Air Force are starting to look at commercial spinoffs of their training and analysis software. The $470 million recreational/educational software market is a tempting target for these institutions, which are searching for new fiscal strategies in a dawning era of potential budget cuts.

The real golden age for home computer users may be when these two camps—recreational and technical—begin incorporating what the other has to offer. Until then, armchair space explorers will find plenty on the market to amuse, challenge and, yes, occasionally frustrate them.

Of the several space-related programs I sampled, the one I found most engaging is **Space MAX** (Final Frontier Software, Tarzana, California, $49.95), a space-station construction simulator that combines the challenge of working in Earth orbit with the trade-offs of business management. *Space MAX* turns the user into a project manager for a commercial consortium whose goal is to make money on three key space-station activities: materials processing, astrophysical observations and scientific experimentation.

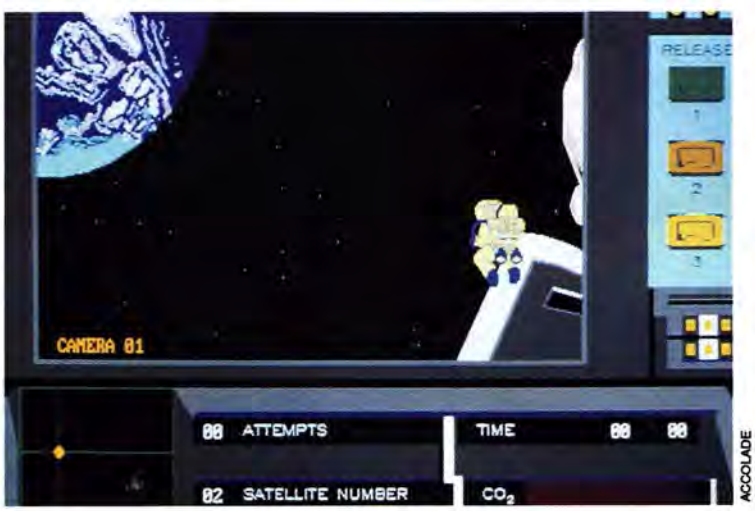
The difficulty level can vary depending on the assigned budget and number of project days. Early flights must stockpile whatever supplies are needed to sustain the assembly effort. The program rudely alerts the operator if, say, the work force in orbit is insufficient for a given assembly sequence. Meanwhile, a spreadsheet displays your dwindling supplies, mounting costs and looming deadlines. *Space MAX* gets its authenticity from these business realities, but as "recreational" software, it may be too serious and technically detailed for many general users.

Spaceflight simulation programs have a potentially wider audience, but here again, the appeal is often limited by complexity. **Apollo 18** (Accolade, San Jose, California, $39.95 for IBM) departs somewhat from realism to make itself more entertaining. The major steps of this simulated lunar mission are executed manually, including lift-off, mid-course corrections, module docking and landing on the Moon—all maneuvers that in real life would be controlled by computers, human reactions being too imprecise. The skill needed to play *Apollo 18* is similar to that required for popular video games. But like most software derived from the space program, operators must study lengthy documentation before beginning.

Orbiter (Spectrum HoloByte, Alameda, California, $49.95 for IBM) gives users a taste of flying the space shuttle. This program's strongest feature are the in-flight emergencies, which are dished up without warning. During my first time out, a fire destroyed the orbiter before I

Accolade's *Apollo 18* simulates a mission to the Moon, from liftoff through in-space maneuvers and a lunar landing.







SPECTRUM HOLOBYTE

Spectrum HoloByte's *Orbiter* gives users a taste of flying the space shuttle.

could trigger the appropriate fire suppression system.

Home computer operators have one handicap here: Keystrokes are required to view control panels, whereas shuttle pilots merely shift their eyes or, at most, turn their heads.

Other software packages concentrate on unmanned space exploration. **Space-90** (Space Analysis and Research, Colorado Springs, Colorado, $60) offers an impressive array of facts about past satellite launches, including launch attempts. **Space Birds** (Astronomical Data Service, Colorado Springs, $41.50) takes the knowledge of a former Air Force orbital dynamicist and turns it into a model for predicting the naked-eye visibility of artificial near-Earth satellites. The output includes data listings on local crossing times, the amount of illumination by the Sun, angles of separation from the Moon, and degrees of



Proxima Centauri-the nearest star *edition of 950* *by David A. Hardy*

This is not science fiction

It's more! NOVAGRAPHICS' space art is a revolutionary fusion of fine art and current scientific data, blended to create dazzling scenes of other worlds. Our all-star team of artists are expert in their subject matter and their media: planetary landscapist ***Kim Poor,*** artist/astronaut ***Alan Bean,*** British master ***David Hardy,*** Emmy award-winner ***Jon Lomberg*** and over a dozen other top space artists contribute to our unique selection of collector's editions, posters, and cards, conveniently available by mail.

Quick shipping • toll-free credit-card orderline • framing available • guaranteed

Send $1 for our beautiful color catalog

NOVAGRAPHICS SPACE ART GALLERY

PO Box 37197-K
Tucson, AZ 85740-7197



(A) SPACE SHUTTLE #1. 15⅝×12⅝"



(B) APOLLO/SKYLAB/SOYUZ



(C) MERCURY/GEMINI

(D) SPACE STAMP

(E) SHUTTLE UPDATE
(F) APOLLO 11 COMMEM.

Capture The History Of Space Flight™

Official astronaut crew insignias and NASA program designs are vividly captured in handcrafted Cloisonne enamel pins. Our solid oak, easy-open, custom frame allows you to display and wear your favorites. Supplied by Winco to major aerospace companies and NASA, each set beautifully portrays an era of America's space history.

Actual pin size

Join **Winco's Air & Space Collectors Club!** $6.00 membership includes: 2 year, 10% discount card for sets ordered now and all items ordered later; **select 2 of 3 collectables** shown at right ($10+ retail! Apollo 11 key chain, NASA Vector pin, Shuttle program tie tac/chain), and our full line catalog with future updates.



FRAMED SETS: Dimensions on A, B, C, D are 15⅝" × 12⅝", E & F are 9½×11⅝". **(A) SPACE SHUTTLE #1.** (28 pins to STS-26) $89.00; **(B) APOLLO/SKYLAB/APOLLO SOYUZ** (20 program pins) $77.00; **(C) MERCURY/GEMINI** (19 program pins) $76.00; **(D) POSTAL SPACE STAMP** (25 stamp pins to 2½", 1948-1989) $89.00; **(E) SPACE SHUTTLE UPDATE** (STS-27 to STS-34 + 2 special pins, 7 total, add next 10 missions) $43.00; **(F) APOLLO 11 COMMEMORATIVE** (large Apollo 11 pin produced from official 1969 medallion + 6 more greats!) $45.00.

TO ORDER: Send payment to Winco International 9019-E Oso Ave., Chatsworth, CA 91311. Add $2.50 per set P&H. Money back if not delighted – GUARANTEED! Calif. add 6¾% tax. 2-6 week delivery. Catalog and updates only, send $2.00.

Corporate programs and dealer opportunities available.
Winco International is a non-exclusive licensee of the U.S. Postal Service

arc as measured from a reference point in the sky.

Other programs feature graphic models of the Solar System. **Dance of the Planets** (Applied Research & Consulting, Loveland, Colorado, $165) accurately portrays the Solar System with realistic scaling, lighting and imagery. The software calculates the gravitational effects each body has on the others using a data base with 60 satellites, more than 4,100 asteroids and some 1,400 comet appearances.

Dance opens with a simulated "view" of the Solar System from four light-days away. The Sun looks like a very bright star and the planets are difficult to see until the software draws in orbital tracks. Colors are realistically muted. The user can reconstruct orbit-changing encounters of the past and even predict events of the future. A novice would be unlikely to enjoy much of what the software has to offer, however; *Dance* is a powerful tool



Space Max is engaging, but may be too technical for the casual game player.

more suited to experienced astronomers.

In contrast, **Computer Guide To The Solar System** (Winter Tech, Orlando, Florida, $54.95) provides simple but fascinating text surrounded by spectacular graphics. Users can easily access the many displays, while color graphics and animations convey a sense of the Solar System's vast scale, violent motions and extreme temperatures. Especially effective is the portrayal of Pluto and its companion Charon orbiting about their common center of gravity as if connected by a rigid bar.

Even this visually appealing program is more an educational tool than a source of entertainment—and that more or less sums up the entire lot. *Space MAX* is a masterpiece and *Apollo 18* is a step in the right direction, but to cash in on the consumer market, space-simulation software makers will have to look for new ways to increase the entertainment factor. □

S A N N I



Columbia, America's veteran of the shuttle fleet during an 'OMS' burn on STS-5, is strikingly rendered in this beautiful limited edition print. This, the first in a series documenting the history of the space effort, was reproduced from the original oil painting by space artist Mike Sanni. Initial response to this work has been overwhelming and it is expected to sell out quickly.

Mr. Sanni's paintings will be on exhibit at the Johnson Space Center from June 4 through June 15.

Each print is individually signed and numbered by artist, Mike Sanni, and by the author of the widely acclaimed book, *Entering Space*, STS-5 astronaut, Joe Allen. Edition size of 750 and 50 artist proofs. Image size of 18" x 18". Mail check or money order with your name, address (please, no P.O. Box) and telephone number to SPACEART Editions. Print, $65.00. Artist proof, $100.00. Texas residents, add 8% tax.

SPACEART EDITIONS
P.O. Box 890212
Houston, TX 77289-0212
(713) 486-8518
FAX: (713) 486-4483

"COLUMBIA"

"The Computer Guide to the Solar System is an impressive product- easy to use, fun and educational. . ." - START magazine

for ATARI ST and IBM-PC

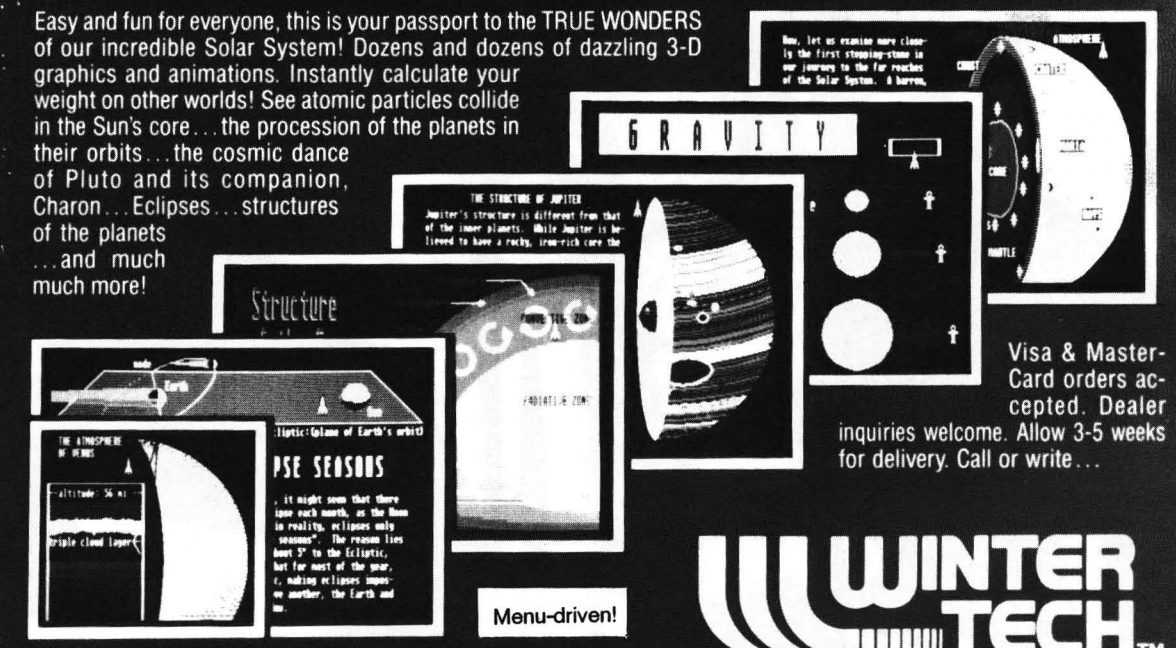
NEWLY UPDATED! With information from the VOYAGER'S Neptune encounter!

WinterTech presents . . .

The Computer Guide To The Solar System™

. . . a real-life adventure in space science!

Easy and fun for everyone, this is your passport to the TRUE WONDERS of our incredible Solar System! Dozens and dozens of dazzling 3-D graphics and animations. Instantly calculate your weight on other worlds! See atomic particles collide in the Sun's core . . . the procession of the planets in their orbits . . . the cosmic dance of Pluto and its companion, Charon . . . Eclipses . . . structures of the planets . . . and much much more!



Menu-driven!

Visa & MasterCard orders accepted. Dealer inquiries welcome. Allow 3-5 weeks for delivery. Call or write . . .

$54.95 (U.S. funds)

In North America add $3.00 S/H.
All other orders add $6.00 S/H.

WINTER TECH™

111 Granada Court, Orlando, FL 32803
(407) 425-1199

"Graphically it is a piece of art . . . forget about time for awhile, it is that engrossing . . . very user friendly . . ." - VANTARI Newsletter

". . . a program with nearly universal appeal . . . broadly intended for just about any age group . . . I only wish there was a program like this when I was in school. . ." - ST WORLD magazine

Not copy-protected.

IBM PC version requires 512K of RAM, DOS 2.0 or higher, EGA or VGA color graphics with 256K of video RAM.

Atari ST versions require color monitor. 1-MEG and 512K ST versions available.

Please specify computer and disk size.



A veteran pilot at 28, Jerrie Cobb possessed that unique blend of physical toughness and technical skill demanded from the first astronauts.

PHOTO COURTESY LILLIAN KOZLOSKI

The

They wa
And they'
By Lillian

"I beat John Glenn on the stress tests, bicycle analysis tests and lung power tests. I beat Wally Schirra on vertigo and set a record in the bicycle endurance and isolation tests. I had something like 10,000 hours of flying time and most of the Mercury astronauts had an average of four to five thousand. I had the college degree. I was sure I was going to make it. I just knew it."

But Mary Wallace Funk didn't make it. In spite of her medical test results, flight hours and college education, "Wally" didn't make the cut. Neither did Jerrie Cobb, who had logged more than 7,000 hours of flight time, broken the sound barrier in a TR-102 Delta Dagger and grabbed several world records with her flying. Neither did any of the other 11 women pilots who pedaled, ran, muscled, sweated and bled their way in 1961 through the rigorous physical, medical and psychiatric tests designed to separate those who had the "right stuff" for space-flight from those who didn't.

They had hoped to be the country's first women in space, and they had reason to think a few might make it. But no one had warned them that having the "right stuff" might also mean being the "right sex." When Alan Shepard and the rest of the Mercury Seven fraternity blasted into the record books, these "Fellow Lady Astronaut Trainees" were left standing in the dust. Today, not so much as an asterisk marks their place in space history.

Just why they never made it can still be debated. Some say it was simply because they weren't military pilots. Others say it was a matter of clashing egos, or even betrayal. But one thing that surely helped to keep these women out of orbit was a society that was not yet ready to envision them there.

It happened to be the late 1950s, at a time when American school kids were learning to count "3-2-1-dammit!" as our rockets blew up on the pad, while the Soviets routinely boosted theirs into orbit. Laika the dog made headlines with a flight into space two years before Uncle Sam lofted monkeys Abel and Baker. Word had it that the Soviets would soon be sending up humans.

A frustrated NASA needed to put a good face on the bad news out of Cape Canaveral. Someone thought the time was right to begin recruiting qualified candidates for space travel — fit young specimens who would serve as living testimonials to America's technological supremacy. Officials drew up a list of criteria, which included the ability to endure extremes of stress, isolation, physical and mental exertion, radiation, the heat of re-entry and whatever other terrors awaited the human body in space.

More specifically, the candidates would be 40 or younger and no taller than 5 feet, 11 inches. They would be in excellent physical shape, have a bachelor's degree or its equivalent and at least 1,500 hours total flying time. In addition, they would be military test pilots who were qualified to fly jets.

It was Eisenhower who reportedly gave the order that limited candidates to military test pilots, presumably to keep this high-risk, high-liability program free from would-be thrill-seekers. He believed test pilots were the only ones who had the security clearance and the right skills to operate within the structure of an experimental, government-funded engineering program, and the only ones who could be relied on — or ordered — to stick with that program.

This stipulation effectively shortened the list of candidates. There were only two U.S. test pilot schools — the Navy school at Patuxent River, Maryland, and the Air

e Wrong Stuff

ıted to be the first American women in space. re still wondering who scrubbed the mission.

Kozloski and Maura J. Mackowski





PHOTOS COURTESY THE LOVELACE FOUNDATION

Jerrie Cobb (left) and Myrtle Grey Thompson Cagle: finding their thresholds for pain, stress and monotony.

Force school at Edwards, California. Each produced a mere dozen graduates a year, and all were male. The order limiting the pool of potential astronauts to this elite group thus also blocked the way for women, who were barred from serving as military test pilots.

On April 2, 1959 the names of America's first seven star-travelers were announced: Alan Shepard, Gus Grissom, John Glenn, Scott Carpenter, Wally Schirra, Gordon Cooper and Deke Slayton. The first Americans in space seemed destined to be an all-male club. But the door for women was not entirely closed — or so it seemed.

Watching these events was a pilot acknowledged by Chuck Yeager and other top-notch male flyers to be their peer in the cockpit. Jacqueline Cochran had more than 13,000 hours commanding both civil and military aircraft, as well as hundreds of hours in high-performance jets. In 1953 she had become the first woman to break the sound barrier. She also had organized and directed more than 1,000 women pilots in World War II, earning for her services with the non-military Women Air Force Service Pilots, or WASPs, the Distinguished Service Medal and later the Distinguished Flying Cross. Her mantel was crammed with trophies and prizes from the Bendix and other air races.

Cochran also had connections. She had a reputation for leveraging every contact she made through her flying career and through her marriage to Floyd Odlum, head of the Atlas rocket company. It was networking as much as skill and aggressiveness that gave her access to planes and facilities no mere civilian — let alone a woman — would normally get to use. Yeager personally coached her for some of her record-breaking jet flights, while Northrop and Lockheed put her on the payroll so she could fly some of the hottest jets around in search of new records to smash.

Cochran was already in her early 50s at the start of the Mercury era — too old by a decade to qualify as an astronaut. She nonetheless set about trying to snag a piece of the action. "I had every intention of following my high-performance aircraft adventures with a trip into space," she wrote in her autobiography. "So I got myself teamed up with my good friend Randy Lovelace, M.D., working at the Lovelace Clinic in Albuquerque, New Mexico to test women for astronaut abilities. I also got appointed as a consultant to NASA space chief James Webb."

It was Lovelace who had helped NASA draw up their profile of the perfect astronaut, and whose clinic had narrowed down the Mercury candidates with a special testing regimen. Lovelace returned from a meeting of space scientists in Moscow in 1959 with word that the Soviets were possibly training female cosmonauts. He himself was curious about comparing male and female physical reaction in the context of space travel — curious enough to consider testing a group of women as he had tested the Mercury candidates.

Shortly after returning from Moscow, he met a woman named Jerrie Cobb, a 28-year-old professional pilot with 16 years experience, 7,000 hours of flying time and

---

A Countdown Deferred

The women who volunteered in 1961 to be tested as potential astronauts were in many ways as well trained and committed to aviation as their male counterparts, the Mercury Seven. That they achieved such success in an era when women were not widely encouraged to do so made them all the more unique. The 12 "FLATs" were:

Mary Wallace "Wally" Funk II

Only 22 at the time of the Lovelace tests, Funk was the youngest of the group. She had graduated from Oklahoma State at age 20, where she led the school's team in aviation competitions before becoming an Army flight instructor.

Jean Hixson

Then 39, she was a WASP engineering test pilot at a B-52 base in World War II. Afterwards she became a flight instructor and earned bachelor's and master's degrees. An Air Force Reserve officer, she was the second woman to break the sound barrier.

Geraldine Hamilton Sloan Truhill

At 33, she had been flying for 19 years. She was a pilot for a Dallas firm that modified, maintained and sold aircraft. They were developing a terrain-following radar for the first aeronautical infrared systems, and part of her job was to coordinate design of the systems with flight crews and engineers.

Marion and Jan Dietrich

Twin sisters who at age 36 had been flying for 20 years, they had been winning against male competitors in air races since they were teenagers. Each had commercial and

three world speed and altitude records. Lovelace and another pioneer in aerospace medicine, Brigadier General Donald Flickinger, were floored by this young pilot and her impressive credentials. Her father had fitted an old Waco biplane with seat cushions and blocks on the pedals so she could learn to fly at age 12. Since then, she'd ferried both commercial and military planes around the world while earning several aviation honors. More recently, she'd been setting records as the pilot of an Aero Commander owned by her current employer, the Aero Design and Engineering Company in Oklahoma City.

Lovelace and Flickinger were interested in Cobb. Medical and psychological investigations, they said, had shown that women were better than men at withstanding pain, heat, cold, loneliness and monotony. Lovelace wanted to correlate these findings with the stresses of long spaceflight. He sought a group of female pilots with whom to begin preliminary research on the role women could play in space travel. And he wanted Jerrie Cobb to participate.

In February 1960, Cobb reported to the Lovelace Clinic in Albuquerque as the first female test subject. Over the next five days she would undergo some 75 medical tests designed to probe for the slightest physical defect. Movies were made of her heart, her retinas were photographed and ice water was injected into her ears to induce vertigo. She was tested for her ability to see in the dark and to speak clearly into a microphone.

When the results from this first phase of testing were tabulated, Cobb still looked as qualified on paper as she had in life. Later that year, in August, Lovelace delivered a paper in Stockholm announcing the results. A space-happy international press had a field day with the idea of a program — apparently endorsed by NASA — for sending women into orbit. *Time, Life, Sports Illustrated*, the *Today Show*, the television networks and the major wire services all wanted a piece of Jerrie Cobb. There were parades in her honor, lucrative advertising endorsement offers and fan mail from around the world.



PHOTO COURTESY LILLIAN KOZLOSKI

Jacqueline Cochran and NASA space chief James Webb.

Earlier that year, *Look* magazine had already gone so far as to speculate about "What The First Space Girl Will Be Like." This "capsule image" revealed more about the mindset of an era than it did about the real demands of space travel for women: "Our first girl in space will probably be flat-chested, lightweight, under 35 years of age and married. Though not an outstanding athlete, she will have extraordinarily precise coordination. She will be a pilot...Her personality will both soothe and stimulate others on her space team.

"Her first chance in space may be as the scientist-wife of a pilot-engineer," the article predicted. "She will not be bosomy because of the problems of designing pressure suits. She will not smoke or have a history of major surgery or mental disorder. Her menstruation will be eliminated by inhibiting medication. She will be willing to risk sterility from possible radiation exposure."

But the woman with the best *real* shot for getting into space was looking more and more like Jerrie Cobb.

A few weeks after the Stockholm conference, Cobb began phase two of the assessment program. She reported to the Veterans' Administration Hospital in Oklahoma City for a series of psychological tests, including one the Mercury astronauts had not had to contend with: the isolation tank. Like the other women who would soon follow her, Cobb was set afloat in complete darkness and silence, in a pool of body-temperature water that denied her almost all sensory stimuli. It was an effort to simulate the weightlessness and emptiness of space.

Test subjects had previously lasted about 4 1/2 hours before lapsing into hallucinations. Cobb lasted 9 hours and 40 minutes.

Based on such tests, Cobb wrote in her 1963 autobiography *Women Into Space*, the physicians believed that she personally was

continued on page 52

---

instructors' licenses and had broken the sound barrier in jets.

Rhae Hurrle Allison

At 32, a charter pilot and instructor, she delivered planes around the country for an aircraft brokerage business.

Myrtle Grey Thompson Cagle

By age 38 she had flown for 24 years. She operated the Selma, North Carolina airport for 10 years and had over 8,000 hours of flying time.

Jane Briggs Hart

A seasoned pilot at 41, she ferried her husband, Philip Hart, during his campaign for the U.S. Senate and later flew Rose Kennedy along the campaign trail for her son John.

Gene Nora Stumbough Jessen

Then 26, she had gone to work after graduating from college for an aircraft manufacturer, teaching flying and demonstrating planes.

Irene Leverton

Also an avid parachutist, the 36-year-old pilot supervised a flying school in California.

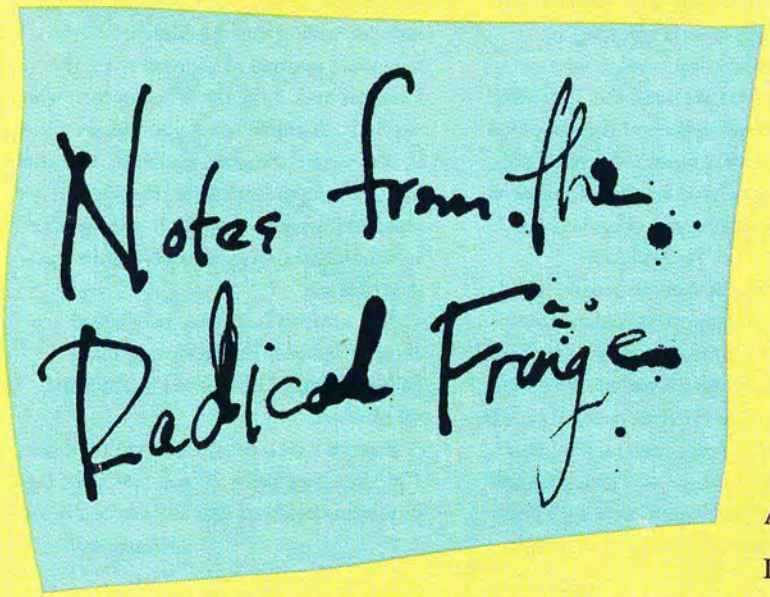
Sara Lee Gorelik Rately

At 29, with a degree in mathematics, she was an experienced aviator working for AT&T as an engineer.

Bernice Trimble Steadman

Then 37, she had stopped logging her flight hours after reaching the 10,000 mark. She had air transport, instrument and instructors' ratings, took part in transcontinental air races and owned an aviation school in Flint, Michigan.

AH, HUMANITY! ✯ JUST WHEN OUR PHYSICS AND ASTRONOMY HAVE GIVEN US AN IDEA OF *WHERE* IN THE UNIVERSE WE TRULY ARE, COMES THE DAUNTING REALIZATION OF HOW VAST THAT UNIVERSE IS, AND HOW MONUMENTAL THE TASK OF CROSSING IT. FOR ALL OUR NEW KNOWLEDGE, THE STARS REMAIN QUIETLY BEYOND OUR REACH. WE CAN LOOK, BUT NOT TOUCH. THE GREEK GODS WHO PUNISHED NARCISSUS AND SISYPHUS NEVER IMAGINED A MORE EXQUISITE TORTURE. ✯ SO WE BUSY OURSELVES WITH CRUDE EXPEDITIONS TO THE BARREN ROCKS OF OUR OWN SOLAR SYSTEM, AND SHUT OUT THOUGHTS OF HOW MUCH MORE IS YET TO BE EXPLORED.✯ MOST OF US DO, ANYWAY. FOR THE VISIONARIES ON THE RADICAL FRINGE, THAT ISN'T ENOUGH. IF KUBRICK AND CLARKE ARE RIGHT, WE TWENTY-FIRST CENTURY HOMINIDS ARE STAR CHILDREN, WAITING AT LAST TO BE BORN. BUT TRUE VISIONARIES KNOW THAT CONQUERING SPACE WILL DEMAND MORE THAN JUST POWER AND SPEED. IT ALSO WILL REQUIRE CLEVERNESS AND AN OPENNESS TO NEW THINKING. THAT IS THE WISDOM OF THE RADICAL FRINGE. ✯ HERE, IN NO PARTICULAR ORDER, ARE A FEW OF THEIR IDEAS. READERS OF SCIENCE FICTION MAY RECOGNIZE SOME OF THEM, FOR NOVELISTS FEEL FREER TO FOLLOW THEIR IMAGINATIONS THAN DO MOST SCIENTISTS. SOME OF THE IDEAS, LIKE KIP THORNE'S AND KONSTANTIN FEOKTISTOV'S, ARE LITTLE MORE THAN SPECULATIONS AT THIS POINT, NOTIONS WAITING TO BECOME PRACTICAL THEORIES. OTHERS, LIKE ROBERT FORWARD'S AND LOWELL WOOD'S, CONTAIN THE SEEDS OF REAL ENGINEERING. ALL OF THEM SHARE A COMMON POINT OF VIEW—A RADICAL WILLINGNESS TO THINK BEYOND THE USUAL AND THE HERE-AND-NOW. ✯ WILL THE EVENTS DESCRIBED HERE COME TO PASS? AS FREEMAN DYSON WRITES ABOUT HIS "SPACE BUTTERFLIES," THE FIRST IN OUR MENAGERIE OF WEIRD AND EXOTIC CREATIONS: "I DO NOT KNOW WHETHER WE WILL ACTUALLY HAVE SPACE BUTTERFLIES BY THE YEAR 2010, BUT WE SHALL HAVE SOMETHING EQUALLY NEW AND STRANGE, IF ONLY WE TURN OUR BACKS TO THE PAST AND KEEP OUR EYES OPEN FOR THE OPPORTUNITIES WHICH ARE BECKONING US INTO THE TWENTY-FIRST CENTURY."



—TONY REICHHARDT



Astro Chickens and Space Butterflies

Like most of us, Freeman Dyson was impressed by Voyager 2's flyby of Uranus in 1986—so impressed, in fact, that he immediately started dreaming about a Uranus 2 mission in 2016.

Next time, says the author and Princeton physics professor, things will be different. Dyson would hope to send a spacecraft weighing a couple of pounds instead of Voyager's ton, which would reach Uranus in two years instead of nine. Instead of Voyager's quick flyby, Uranus 2 would land on each of the planet's moons, take off again, and land somewhere else. The spacecraft would be small, quick and, in its own way, simple. Dyson gives it the unpretentious name of "Astrochicken."

Asking so much of so small a spacecraft is well beyond today's technology. If NASA tried to design all those capabilities into a single mission using 1990 methods and materials, we would have to send something the size of an aircraft carrier to Uranus. But Dyson, whose fertile mind has given birth to, among other things, designs for nuclear-powered starships and "gravitational machines," thinks that the space program of the next century will be radically altered by two technologies that are being developed in parallel to our efforts to reach out into space: artificial intelligence, and perhaps even more importantly, genetic engineering.

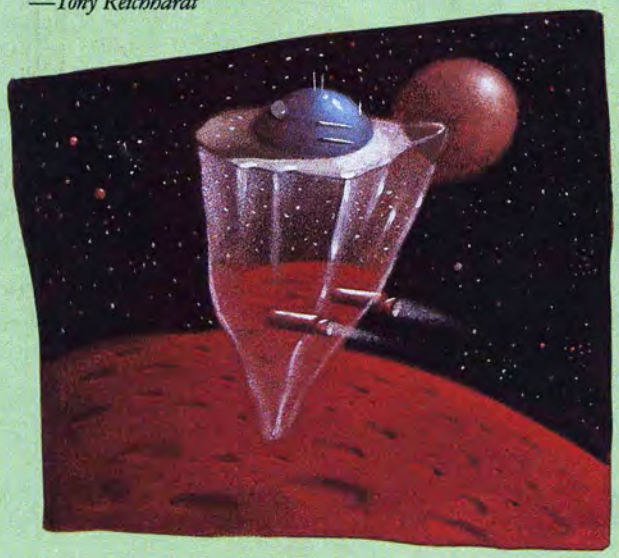
Dyson, lover of the simple and the elegant, hater of bureaucracy, admires the efficiency with which nature pack-

ILLUSTRATIONS BY TIM JONKE

ages information and technology into living beings, whether insects or humans. Once we become smart enough to manipulate DNA the way that nature does (Dyson thinks that's inevitable) he envisions such combinations of animal and machine as the "space butterfly," which he describes in his 1988 book *Infinite in All Directions*: "...a living creature, fed on Earth like a caterpillar, launched into space like a chrysalis, riding a laser beam into orbit, and metamorphosing itself in space like a butterfly. Once it is out there in space, it will sprout wings in the shape of solar sails, thus neatly solving the sail deployment problem. It will grow telescopic eyes to see where it is going, gossamer-fine antennae for receiving and transmitting radio signals, long springy legs for landing and walking on the smaller asteroids, chemical sensors for tasting the asteroidal minerals and the solar wind, electric current-generating organs for orienting its wings in the interplanetary magnetic field, and a high-quality brain enabling it to coordinate its activities, navigate to its destination and report its observations back to Earth."

Dyson believes that the coming revolution in biotechnology will change more than just space travel. There are dangers, of course (Dyson is also an eloquent writer on the threat of nuclear weapons), but there are even more opportunities. Among them is the chance to put our heavy, primitive metal spacecraft away on the shelf forever.

—Tony Reichhardt



IceShips

Get out your earmuffs. If Jonathan Post is right, tomorrow's spaceship may be made of hydrogen ice, spinning through space like a cluster of giant snowballs. As the science-fiction writer/aerospace engineer envisions it, spacecraft made of several kinds of ice—hydrogen, lithium or even plain old water—could theoretically be used to send people to Alpha Centauri. The structure of a hydrogen iceship would itself be used as fuel for a fusion engine, and could act as a radiation shield as well. Post says it's a little like the Marx Brothers film *Go West*, in which Groucho, Harpo and Chico fuel a train's steam engine by chopping up the box cars and feeding the train to itself.

Nested one inside the other, concentric spheres of metal would carry solid hydrogen fuel between their walls. Clusters of these spheres would form the spacecraft itself, "like a cluster of grapes," Post says, and "you would eventually pluck off a sphere at a time and melt that down as fuel."

"The idea is to minimize the amount of useless material," says Post. As in the Marx Brothers movie, "You want to get people where they're going, and everything else is expendable," even walls, which at some point would also be melted down for fuel.

Post has drawn in part on work done by Jim Stephens of the Jet Propulsion Laboratory, whose ideas about iceships evolved from his work studying comets in connection with NASA's planned Comet Rendezvous Asteroid Flyby (CRAF) mission.

Stephens has speculated about future robotic spacecraft made entirely of hydrogen ice, with long, thin filamentary particles of insulating material embedded in their surfaces. "When the ice sublimes away it would leave behind this fiber—a sort of fluffy blanket or mantle" of insulation, grown by the iceship itself. Studies have shown, says Stephens, that an ice sphere one meter in diameter could last 5 to 10 years in orbit around Earth.

Because onboard temperatures would be as low as five degrees Kelvin, all the circuitry could be made of "old-fashioned" (meaning low-temperature) superconducting electronics embedded in the ice. Radar antennae inside the ice could look through it to communicate with and spy on the Earth below.

When Stephens presented his idea to JPL officials two years ago, he says, they quickly hid it away in the vault, apparently embarrassed. After all, who wants a gigantic chunk of hydrogen ice, a sort of "Doomsday Machine" hovering in low Earth orbit? While Stephens has shared his thinking with researchers in the Defense Department, Post is presenting his ideas about iceships at a conference at NASA's Lewis Research Center this spring. But, Stephens says wryly, it may be "an idea whose time has not yet come."

—Ray Spangenburg / Diane Moser



the images would be transmitted back to Earth.

To build such a telescope, it will be necessary to lift large spacecraft into interstellar space and to keep them operating there routinely. An early step in this direction may take shape with NASA's proposed TAU (Thousand Astronomical Unit) mission, which aims to send a small spacecraft out to 1,000 times the distance between the Sun and Earth, on a flight taking several decades, sometime early in the next century.

Eshleman sees gravitational lenses being used not only for telescopes, but as a means for intelligent civilizations scattered around the galaxy to communicate and learn more about each other. In the 1979 paper in *Science* magazine in which he first discussed his idea, Eshleman points out that our strongest radar, TV and other signals are already being "played out" on "screens" focused by the gravitational lenses of distant stars. Meanwhile, he continues, "It is possible that several or many such focused stories about other worlds are now running their course on such a gigantic screen surrounding our Sun, but no one in this theater is observing them."

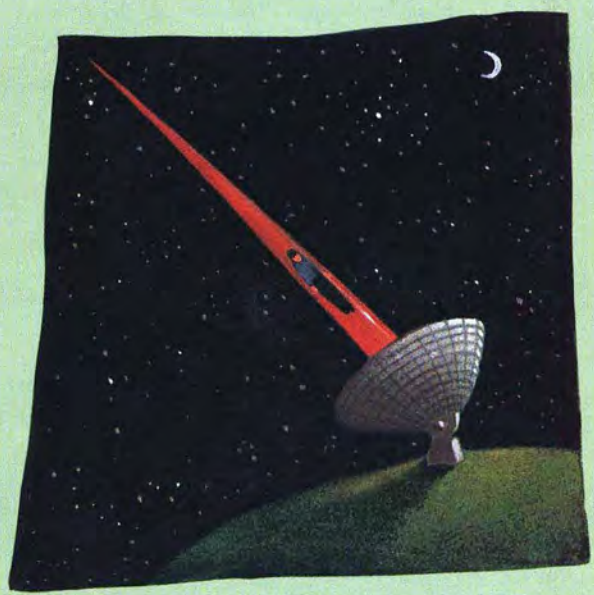
—T.A. Heppenheimer

Superscopes

In the future, it might be possible to look at stars in the Andromeda Galaxy, 2.2 million light-years away, and see planets, even making out features the size of North America. Quasars and other volatile objects far across the Universe would be seen with the drama and vividness of a George Lucas movie. Closer to home, planets around nearby stars would show details the size of houses. In fact, any object in the sky would reveal features 100 million times finer than what will be seen with the Hubble Space Telescope.

All this would be accomplished using a form of "telescope" proposed by Von Eshleman, a Stanford University radio astronomer. The telescope's "lens" would be the entire Sun, whose gravity, in accordance with Einstein's general theory of relativity, makes light bend as it passes by. That bending would bring the light to a focus out in interstellar space, at some 30 times the distance to Neptune.

A spacecraft operating there would see the Sun surrounded by a glowing white ring—the focused light from a distant star or galaxy. By focusing the light, the Sun would act like a movie projector that throws an image onto a screen. A spacecraft equipped with an array of photodetectors would maneuver along that "screen," and



Beamers

Once, in the adventurous days of his youth, Konstantin Feoktistov went for a dangerous ride. It was 1964, and the Soviets were racing to become the first nation to launch a three-man crew into orbit. So they crammed

Feoktistov and two fellow cosmonauts inside a capsule built for one, shut the hatch and fired away. There was no room even for pressure suits—the three circled the Earth in little more than their street clothes. One leak, and the crew of Voskhod 1 would have perished.

Today Feoktistov is a top official in the Soviet space bureaucracy, in charge of spacecraft design. At age 64, his cosmonaut days are over, but he still has the pioneer's fire. Now he dreams of beaming people to the stars.

At a conference held by the Space Studies Institute in Princeton in 1987, Feoktistov delivered a paper speculating on the real possibility of transmitting electronic "personalities" into space. Instead of sending our physical bodies across the vast gulf of interstellar space in slow-moving starships, he proposes beaming the information drawn from a person's perceptions and memories at the speed of light. These "information packages" would bear the same relation to a real human being as computer software does to the machine that runs it.

At journey's end, the electronic "space human being" would be received by an antenna and reunited with a "material carrier" body. Launching the necessary equipment from Earth would be slow and expensive, so Feoktistov suggests beaming instructions ahead to some friendly alien civilization, who could build the receiving stations for us. Then we'd be ready to send out our first interstellar ambassador—not Captain Kirk, but Max Headroom.

Before we start faxing ourselves off to Tau Ceti, however, Feoktistov points to specific areas where more research is needed: contact and communication with extraterrestrials (*they* may in fact be sending us *their* personalities already); construction of large receiving and transmitting antennae (more than several kilometers in diameter, with at least 100,000 megawatts of power); and the formidable problem of creating "artificial intellects" in the first place.

Here Feoktistov may find allies in the field of advanced robotics research. Hans Moravec of Carnegie-Mellon University and other pioneers of artificial intelligence talk brazenly about eventually learning to "download" the contents of the human mind into a computer. By the time they succeed, biotechnologists may be able to write the instructions for constructing a genetically engineered "material carrier."

The implications for interstellar travel, needless to say, would be great. As Feoktistov—the first scientist to reach Earth orbit—said in Princeton, "For this approach to a star journey, we need decades, but not thousands or millions of years."

—Tony Reichhardt



Wormholes

The staid and often mystifying pages of *Physical Review Letters* are not generally the place to look for exotic ideas about interstellar travel. But an article appearing in the September 26, 1988 issue of this prestigious journal begins with the following provocative statement: "It is argued that, if the laws of physics permit an advanced civilization to create and maintain a wormhole in space for interstellar travel, then that wormhole can be converted into a time machine with which causality may be violatable."

There is perhaps no thornier scientific problem than time travel. And there may be no group more up to its theoretical challenge than Kip Thorne and his colleagues, Michael Morris and Ulvi Yurtsever, astrophysicists at the California Institute of Technology. Wormholes as shortcuts across the universe have long been tricks of the trade for science fiction writers wanting to move their characters quickly from Star A to Galaxy B. But why should Caltech astrophysicists take wormholes seriously? The scientists claim that the answer to their question, "What constraints do the laws of physics place on the activities of an arbitrarily advanced civilization?," will "lead to some intriguing question about the laws of physics."

Thorne and his colleagues hypothesize that an advanced civilization might be able to create a wormhole, or passageway in space-time, by pulling it out of the "quantum foam" and then enlarging it to everyday size. Many physi-

cists in search of a quantum theory of gravity that jibes with Einstein's general theory of relativity believe that this quantum foam pervades space at the sub-nuclear level (see "Quantum Drives," this page).

But just because the quantum foam may exist, there's no guarantee that a tiny speck of it could be made big enough to allow the Millennium Falcon to pass through. Stupendous energies and technologies might be required to keep the passage from collapsing, or "pinching off," as the intrepid Caltech time-travelers suggest. Their elaborate analysis also discusses the maintenance of such time-space tunnels by "quantum-field-theoretic stress-energy tensors," whatever those might be. (Remember, we're talking about an *arbitrarily advanced* civilization able to do anything not ruled out by the laws of physics.)

And what would await a wormhole traveler at her destination? A trip down memory lane, perhaps? Violations of the so-called "causality principle"? Would not killing one's grandparents, for example, wipe out one's own existence for all time? The physicists conclude: If the laws of physics permit traversable wormholes at all, then passage through them could be like stepping through a time machine. Cause and effect would be turned upside down. Even the boldest star voyager would have to decide if this particular form of interstellar travel is worth the risk.

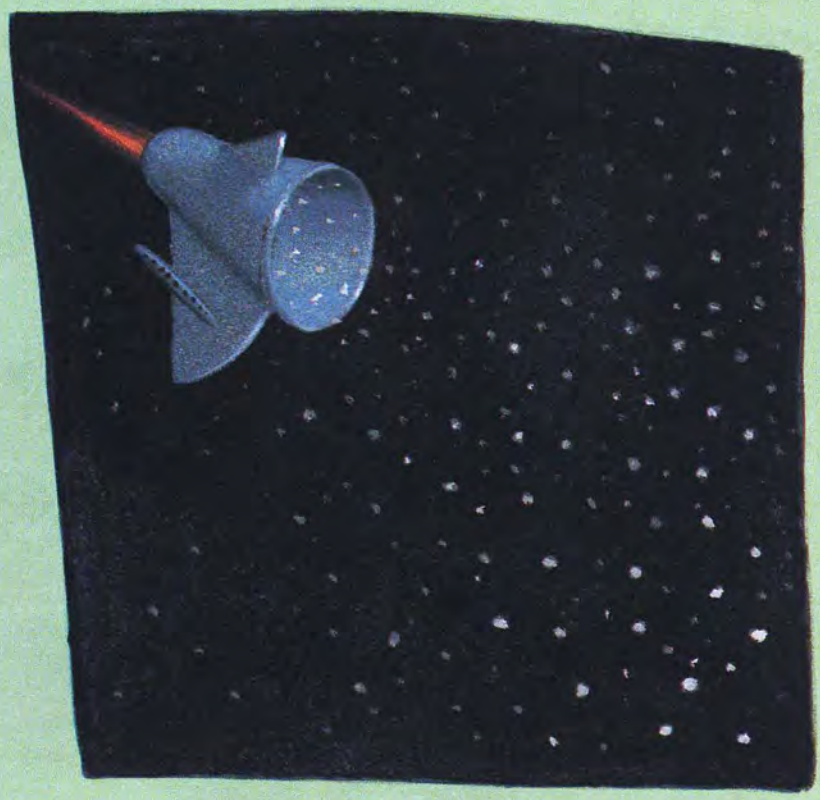
—Eugene F. Mallove

Quantum Drives

There is much more to interstellar space than meets the eye. It isn't just dead vacuum with a few stray photons and electrons rattling around in every cubic centimeter. Down at the magic level of the "Planck scale"—10 billionths of a trillionth of the diameter of a proton—space-time may, according to late 20th-century physics, dissolve into a "quantum foam" of seething energy fluctuations. A single fluctuation might have an energy level as high as hundreds of kilowatt-hours.

The intense curvature in the geometry of space-time itself is responsible for these staggering energies. What if we could tap into just a tiny fraction of that potency? Aerospace engineer H.D. Froning, Jr. of McDonnell Douglas Company posed that very question a little over a decade ago, and in so doing took a quantum leap—literally—beyond Robert Bussard's 1960 idea for a "ramjet" starship that would ingest interstellar hydrogen for use as fusion fuel as it traveled through space. Froning's hypothetical interstellar ramjet would run on the hidden quantum energy of empty space. It would propel itself between the stars by capturing a vanishingly small fraction of the energy of the quantum "fluctuons" rushing toward the spacecraft.

Of course, no one today, including Froning, has the faintest idea of how quantum energies could be converted to a directed radiation beam or stream of particles that could be used in reactive propulsion. But because of the enormous energy density of space, the craft would probably not need a huge scoop hundreds of kilometers in diameter, as does the Bussard ramjet, to gather in its fuel.



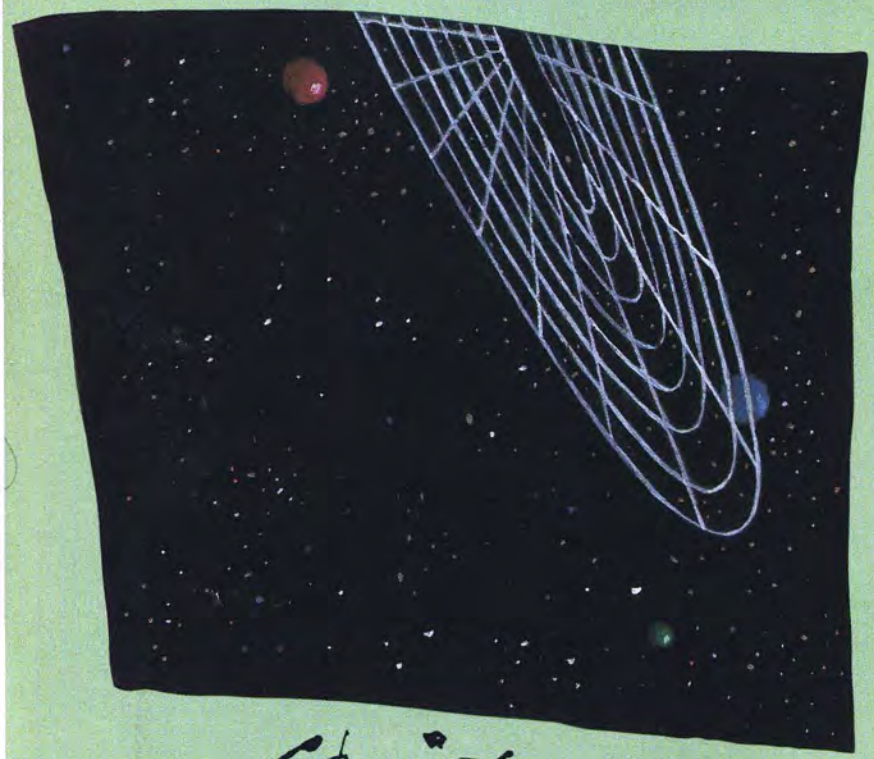
Despite its fantastic nature, Froning's idea may not be so crazy. It does, after all, rely on the theories of respected physicists like John Wheeler of Princeton, who 20 years ago coined the term "black hole." Wheeler's concept—that extremely high-energy quantum fluctuations pervade the vacuum of "empty" space—hasn't yet been proved by physicists, but many believe that it is fundamentally sound and that it underlies the elusive quantum theory of gravity.

Cosmologist Alan Guth of MIT, renowned for his widely accepted inflationary theory of the origin of the Universe, believes that "child universes" may occasionally "bud off" from a quantum fluctuation in our own cosmos, inflat-

ing rapidly and creating large amounts of matter in the new universe. One consequence of Froning's idea, therefore, is that a quantum starship in its travels would be ingesting countless seeds of potential new universes.

The fundamental problem with the quantum starship is whether enough *net* energy could be extracted from the quantum fluctuations in free space. Froning himself admits that "the accomplishment of a propulsive interaction with these invisible and elusive energies is far beyond our current scientific understanding." But the idea of a quantum drive starship is a testament to creative speculation on "impossible" problems, and it shows how much can be accomplished when one thinks very deeply about virtually nothing.

—Eugene F. Mallove



Starwisps

Decades from now, when solar-power satellites are humming along in high geosynchronous orbit above the Earth, physicist Robert Forward wants to borrow one for a few days to propel an intelligent spider web to a nearby star. Normally, the giant orbiting power stations would transmit energy down to an antenna farm on the ground to be converted into billions of watts of central-station electricity. But in Forward's extraordinary vision, the 10 billion-watt microwave beam would instead be turned outward to push the Starwisp—a pancake-shaped mesh of wires a kilometer or more in diameter—on a fast trip to, say, Barnard's star, 5.9 light-years away.

Boosted to 20 percent of light speed in only a few days, Starwisp could execute a fast fly-through of Barnard's planetary system (assuming there is one) within a mere three decades from its launch. Once the probe reached its destination, another blast from the microwave beam back on Earth would hit the wires of the mesh. These would be coated with trillions of microelectronic devices, which together would act as an intelligent data-gathering and transmitting array, able to send close-up pictures of alien planets back to Earth.

Propelling such a delicate web through space using microwaves is very much like pushing a solar sail with light waves, except that microwaves have much longer wavelengths than visible light. To the microwaves, Forward's Starwisp probe would present an opaque, mirror-like surface; the gaps in the web would no more let energy pass through than do the "holes" in a radio telescope dish. Since the web would weigh only a few dozen grams, its acceleration to cruising speed could be very high–as much as 115 g's, or 115 times the acceleration due to gravity on Earth!

Forward's name is almost synonymous with advanced thinking about starflight. The bold and charismatic physicist, who is given to wearing white suits and flashy vests, has done serious pioneering work on more than half a dozen interstellar propulsion concepts. He was the first to suggest (in the early 1960s) the use of a laser to push gossamer-thin sails across the interstellar gulf. In recent years Forward has focused on developing practical ways to generate and use antimatter for space propulsion, and in 1988 co-authored a book on the subject called *Mirror Matter.*

But even with his enthusiasm for antimatter propulsion, Forward is proud of Starwisp as one of his many "rocketless rocketry" ideas. The beauty of the probe is that it doesn't require huge amounts of mass to be carried along just to boost the payload, which is the fatal flaw of many a proposed interstellar voyage.

Is Starwisp mere science fiction? Perhaps today, but not tomorrow, claims Forward. Besides being a versatile physicist who has worked on everything from gravity-wave antennae to optical computers, Forward is among the finest in the school of science-fiction writers for whom believable hardware and science are of paramount importance. Don't bet that a Starwisp won't someday be launched, at least as a "proof of principle" demonstration that high-speed interstellar travel is more than an impossible dream.

—Eugene F. Mallove

continued on page 50

MISSION FILE

STS-36



LAUNCH: 2:50 a.m. EST, February 28, 1990
Pad 39A, Kennedy Space Center, Fla.

LANDING: 10:08 a.m. PST, March 4, 1990
Edwards Air Force Base, Calif.

ORBITER: Atlantis
ALTITUDE: Classified; estimated 110-178 nautical miles

CREW: John O. Creighton, Commander; John H. Casper, Pilot; David C. Hilmers, Richard M. Mullane, Pierre J. Thuot, Mission Specialists

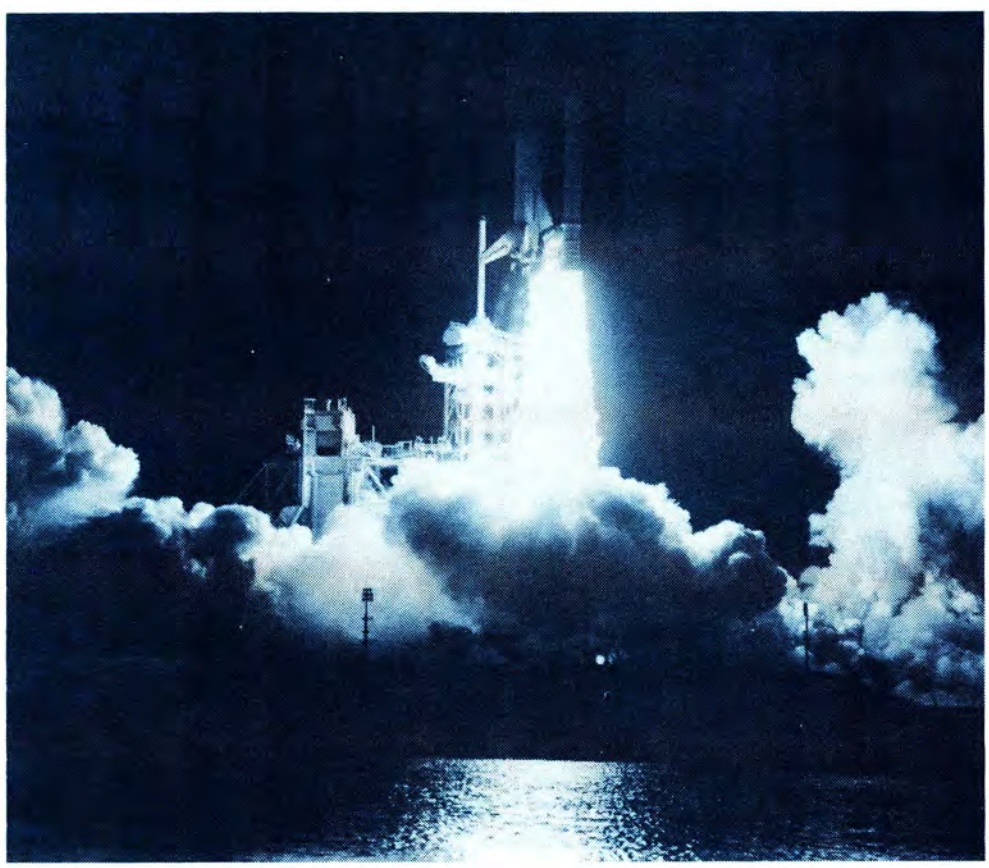
PAYLOAD: Classified; believed to be AFP-731 photo-reconnaissance/signals intelligence satellite

The Berlin Wall may be up for sale and the Moscow McDonald's may serve "Bolshoi Mak" to thousands of comrades daily, but the U.S. intelligence community still wants to keep tabs on what Gorbachev & Co. are up to. That was the assignment NASA and the Department of Defense handed the STS-36 astronauts: launch a massive reconnaissance satellite to spy on Soviet military installations and communications at high northern latitudes.

At times, however, it seemed that Atlantis would never get off the ground for its sixth flight. Originally slated for February 22, the launch was delayed several times by an unlucky combination of sickness, a hardware glitch and the capricious Florida weather.

A severe upper respiratory infection developed by STS-36 commander "J.O." Creighton about a day before the scheduled liftoff caused a two-day postponement. Creighton simply was in no shape to fly. The usual debilitating effects of a bad cold or flu would only have been made worse by changes in atmospheric pressure during the shuttle's ascent and by the nasal fullness (sinuses don't drain in zero-g) even healthy people experience in orbit. NASA had scrubbed a piloted flight due to illness only once before, when the three Apollo 9 astronauts got colds in 1969.

Creighton and his crew were ready to go shortly after midnight on February 25,



Atlantis lifts off, bound for the northernmost trajectory ever piloted by U.S. astronauts

but the launch was cancelled when an Air Force range-safety computer dropped out during the last five minutes before liftoff. NASA tried again the next morning, but the launch window expired with high winds and clouds still plaguing the Cape.

When Atlantis finally roared away from the pad between rain showers on February 28, residents along the East Coast got their first good look at a shuttle ascent. The orbiter rocketed into a trajectory inclined 62.5 degrees to the equator—the northernmost ever for a U.S. piloted flight—that would allow the mission's classified payload to image targets in the high latitudes of the Soviet Union.

The shuttle hugged the Atlantic shoreline as it climbed into space, appearing to most watchers as a bright, yellow-white star that took just a few seconds to transit the sky. Sightings were reported as far north as Dover, Delaware before Atlantis' main engines shut down as planned a few miles off New Jersey.

The STS-36 astronauts spent their first day in orbit activating experiments and handling minor orbiter problems such as a stuck door-latch and a paper jam in their TAGS (Text and Graphics System) super-fax machine. If the crew felt like someone was looking over their shoulder, they had good reason: One of the medical experiments mounted in Atlantis' cabin consisted of a human skull filled with radiation-monitoring instruments. The purpose of the "Phantom Head" was to obtain data on the amount of radiation an astronaut's body absorbs during a typical space flight.

Early on Flight Day Two, mission specialist Dave



The crew returns: From bottom of steps: Creighton, Casper, Thuot, Hilmers and Mullane.

Hilmers flipped switches to deploy the flight's primary payload, a huge AFP-731 spy satellite. Prior to the mission the aerospace trade publication *Aviation Week and Space Technology* had pegged the satellite's weight at around 37,000 pounds, reporting that it would be rolled into orbit using a new Stabilized Payload Deployment System built by Rockwell International, manufacturer of the shuttle orbiter. The magazine also said the spacecraft contained a high-resolution digital imaging system and sensitive electronics to detect secure Soviet military communications.

There were preflight rumors that NASA and the Defense Department were prepared to loosen the blanket of secrecy that envelops military shuttle flights, but leaks of classified information about the STS-36 mission apparently steamed Bill Lenoir, NASA's space flight boss and a former astronaut. In a February 13 memo, Lenoir sternly reminded NASA employees that "NASA plays a critical role in maintaining the national security of the United States," and that any breach is "a violation of federal law requiring...prosecution to the fullest extent of the law."

While NASA refused comment about Atlantis' payload, the daily systems reports issued by the space agency showed that the orbiter winged its way through space with few difficulties. The Flash Evaporator System used for environmental control shut itself down on the mission's second day, but worked fine after the astronauts reset it. One of the display screens on the flight deck also went on the blink and had to be replaced.

On Flight Day Three, the crew mopped up about a quart of water from "the bilge," a compartment beneath the mid-deck floor that contains Atlantis' humidity separators; a similar problem had troubled Columbia's astronauts on STS-32 in January. And during a test the day before re-entry, shuttle commander Creighton and pilot John Casper found that two of the orbiter's right rear maneuvering rockets (one thrusting sideways, the other down) wouldn't fire, and the astronauts shut them down for the duration.

When high winds at the shuttle's Edwards Air Force Base landing site dropped to acceptable limits, Mission Control cleared the astronauts to light up Atlantis' two orbital maneuvering engines to begin the long descent through Earth's atmosphere. En route to Edwards, the crew noticed a pressure drop in the hydraulic system that controls the spaceplane's flap-like elevons, rudder and brakes. Technicians later found that a split high-pressure hose on Atlantis' #1 Auxiliary Power Unit (APU) had sprayed hydraulic fluid throughout the aft engine compartment.

Creighton and Casper handled the problem without using backup systems, and brought Atlantis in for a smooth touchdown on Edwards' desert lake-bed runway. Only the media and invited guests were authorized to watch, however; the Air Force put the usual spectator sites off limits to the public as it had for past "classified" flights.

The secrecy surrounding STS-36 didn't dampen the enthusiasm of its crew. Rookie mission specialist Pierre Thuot confided after the landing that he was "in awe" during the shuttle's rush to orbit. Pilot John Casper echoed that sentiment, calling his whole flight "a fantastic experience."

But for veteran mission specialist Mike Mullane, who had previously announced his retirement from the astronaut corps, STS-36 marked the end of a career rather than a beginning. "I'll be sitting there watching shuttles fly into space," a wistful Mullane said of his postflight plans. "I'll envy that."

SPACE MATERIALS

call us toll free 1 800 24-LUNAR!



SPACE MUSIC
A must for all astral travellers, dreamers and music listeners who like to drift into space.
Compact Discs **$14.95**
Cassette Tapes **$9.95** (s/h $1.50 each)

Atlanta planetarium composer Jonn Serrie captures the mystical powers of the universe with warmth and vision.
"FLIGHTPATH"
CD **#02** Cassette **#03**
"AND THE STARS GO WITH YOU"
CD **#04** Cassette **#05**

Ian Tescee explores connections with vibrant soundscapes of electronic and acoustic textures inspired by the solar system.
"CONTINUA" CD **#06** Cassette **#07**
"IO" CD **#08** Cassette **#09**

Michael Lee Thomas blends synthesized melodies with actual space sounds beamed from Voyager 2. Endorsed by JPL.
"VOYAGER-GRAND TOUR SUITE"
CD **#10** Cassette **#11**

SHUTTLE FLYING MODEL STARTER SET
#01 It really flies! Over 10" high, can be launched to an altitude of 500 feet. Returns to Earth via 18" parachute. Shuttle model, launch controller, launch pad, three engines, ignitors and wadding. Adult supervision recommended for children under 12. **$32.95** (S/H $3.00 each) Not available outside of USA.





DIE CAST SHUTTLE REPLICAS
Features retractable landing gear and moving parts.
747 w/ SHUTTLE (removable) **#19**
6"x5¼"x2", **$8.95**
SHUTTLE WITH ARM #20 (opening doors, removable payload) 7 1/2"x 4 3/4"x2 3/4" **$12.95** (S/H $2.50 each)

COLOR SLIDE SETS
Specially compiled by Final Frontier's photo editor. Dramatic, full-color images.
APOLLO 11-MOON LANDING #21
(20 Slides) **$14.95**
MANNED LAUNCH VEHICLES #22
(20 slides) **$14.95**
VIEWS OF THE PLANETS #23
includes Neptune (20 Slides) **$14.95**
THE BEST OF THE SHUTTLE PROGRAM #24 (40 slides) **$24.95**
(S/H $1.50 each set)





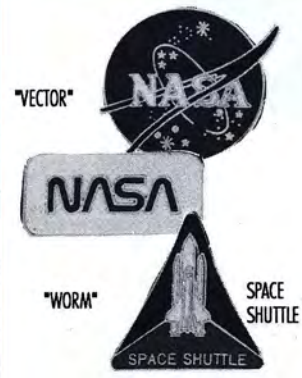


NASA T-SHIRTS
#25 White t-shirt w/NASA "vector" logo in blue **$10.95**
Available in Lg & X-Lg only (S/H $1.50 each)

NASA ASTRONAUT CAPS
Quality sports cap like the astronauts wear. Adjustable, fits all sizes.
BLACK CAP #12 w/NASA "worm" logo **$9.75**
WHITE CAP #13 w/NASA "vector" logo **$9.25**
(S/H $1.50 each)

NASA SATIN SPORT JACKET
#14 100% Dupont nylon outer with Kasha interling and NASA logo. Available in red, royal & black. (Please specify color choice) **$39.95** Specify size: Med, Lg, X-L (S/H $2.00 each)

SPACE COLLECTOR PINS
Jewelry quality cloisonne lapel pins of official NASA designs.
NASA LOGO "VECTOR" #15 $5.00
NASA LOGO "WORM" #16 $5.00
SPACE SHUTTLE #17 $5.00
SHUTTLE PROGRAM SERIES #18
(thru STS-30) **$129.95**
(S/H $2.50 each set)





DESKTOP DISPLAY SCALE MODELS

Highest quality, completely assembled and finished with authentic markings. Includes varnished wooden base. (S/H $6.00 for Large Shuttle, $4.00 each all others)

SMALL SHUTTLE (shown)
#60 w/tank & boosters 1/200, 11"x 4 1/2", **$54.95**

LARGE SHUTTLE
#61 w/tank & boosters 1/100, 25"x9", **$219.95**

SMALL ORBITER
#62 1/200, 7 1/4"x4 1/2", **$34.95**

MEDIUM ORBITER
#63 1/144, 10"x6 1/4", **$59.50**

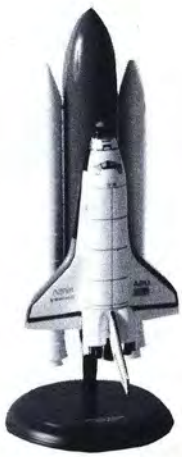
LARGE ORBITER (shown)
#64 1/100, 14 1/2"x9 1/4", **$99.50**

DESKTOP SOVIET SHUTTLE (shown)
#65 Actual Soviet made model of the Buran shuttle complete with authentic markings. 1/200, 8"x4 5/8" **$59.95**

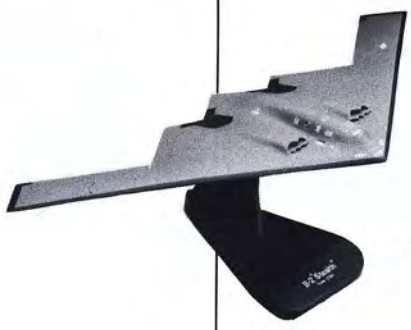
B-2 STEALTH BOMBER (shown)
#66 1/100, 8"X20 1/2". **$119.50**

X-15 AIRCRAFT (shown)
#67 1/48, 13"x5 1/2". **$79.50**

X-1 AIRCRAFT (shown)
#68 1/32, 11"x9 1/2". **$79.50**



SHUTTLE WITH TANK AND BOOSTERS



B-2 STEALTH BOMBER



X-1 AIRCRAFT X-15 AIRCRAFT



ORBITER



DESKTOP SOVIET SHUTTLE

FOR FAST DELIVERY CALL 1(800)24-LUNAR

or FILL OUT AND MAIL TO:
FINAL FRONTIER SPACE MATERIALS
2400 FOSHAY TOWER,
MINNEAPOLIS, MN. 55402
or FAX US AT (612)332-0034 (Credit card orders only.)

Name _____

Address _____

City _____ State _____ Zip _____

Daytime phone _____

METHOD OF PAYMENT 5/690

☐ check/money order ☐ Visa ☐ Mastercard ☐ AmEx

credit card no. _____ exp. date _____

signature _____

BOOKS SHIPPING AND HANDLING $2.50 FIRST BOOK $1.00 EACH ADDITIONAL BOOK

QTY	ITEM #	ITEM NAME	COLOR/SZ	PRICE	*S/H*	TOTAL

Allow 4-6 weeks for delivery. Some items may take longer due to availability. *Double S/H for Canadian surface shipment, triple overseas.

TOTAL ORDER



MOON MAP

#26 Unique map glows in the dark for more than 3 hours, recharges by light. Over 150 scientifically-accurate features. Non-toxic moon is a large 26" in diameter! **$18.95** (S/H $2.00 each)

SOLAR SYSTEM EXPLORATION MAP

#27 36"x36" map shows planets, larger moons, large asteroids and comets. Trajectories of inter-planetary spacecraft are shown in phosphorescent ink. Bottom panel depicts the pioneering spacecraft. Glows in the dark. Includes 29 page booklet. **$10.95** (S/H $2.00 each)

SPACE STATIONS POSTER

#28 The evolutions of space stations from the 1960's to the most recent designs in a stunning 36"x36" full color poster. Each craft is identified by its sponsor and project date. Major population centers glow in the dark. Booklet included. **$12.95** (S/H $2.00)

SHUTTLESCOPE BY JASON

#29 Pre-assembled shuttle telescope features 50mm objective lens and 600mm focal length, 6mm and 20mm eyepieces, extender tube, adjustable tripod, finderscope and more. Looks great at home or in the office, excellent for beginners. **$99.95** (S/H $6.00 each)



FISHER SPACE PENS

The actual pen of the astronauts. Pressurized cartridge writes upside down, underwater, in freezing & boiling temperatures.

ASTRONAUT PEN: #30 $14.95
BULLET PEN w/SHUTTLE: #31 $16.95 (S/H $1.00 each)



TOWN AND COUNTRY PEN SET BY FISHER

#32 The luxurious Crown Imperial partnered by a matching Bullet Elite which conveniently fits in your pocket, yet opens to a full-sized pen. Hand crafted with multiple luminescent layers of high gloss lacquer, 24k gold plated trim and solid brass construction. Like all Fisher Space Pens, this set carries an unconditional lifetime guarantee. Available in Midnight Blue, Black or Bordeaux. (please specify) **$99.95** (S/H $1.50)





VOYAGER AND GALILEO SCIENCE KITS

Accurate educational model kit (shown assembled) made of laser-precut lithographed heavy weight paper, instructions, detailed information about the spacecraft and its missions. Ideal for teachers and students alike. **Voyager kit #33**
Galileo kit #34 $14.00
(S/H $2.00 each)



SPACE MAX COMPUTER SOFTWARE

#35 Space Station Construction Simulator, based on NASA's program. Combines project management with business strategy in an exceptional simulation. Requires IBM PC or compatible, DOS 2.10 or higher, 192-KB RAM or more, color graphics adapter, color monitor. 3 5½" Floppy discs and extensive operation manual included. **$59.95** (S/H $2.00 each)



VIDEOS

FIND YOUR WAY BACK

#36 "The best shuttle video we've seen" - Final Frontier. All the glory of America's return to space is captured in this unique rock salute to the space shuttle Discovery STS-26. It's the ultimate adventure, from the space program's early days to the present, hosted by the Discovery astronauts and featuring fantastic NASA footage. Includes music by Steve Winwood, Starship and more. 30 minutes **$19.95** (S/H $2.50) VHS only

VOYAGE TO THE OUTER PLANETS AND BEYOND

#37 Hosted by Isaac Asimov, rare NASA and JPL footage is set to the inspiring music of Holst's "The Planets". An inspiring experience with authoritative documents to satisfy both experts and novices. Includes a special 4-color brochure prepared by NASA. **$39.95** (S/H $4.00) VHS only.

NEW!



BREAKOUT INTO SPACE
#38 The empty solar system awaits the next natural step for our species. An argument for stepping away form Earth and settling the solar system. Hardcover: **$16.95**



ALICE AND THE SPACE TELESCOPE
#39 A whimsical yet fact filled guide through the story of the Hubble space telescope—how it was built and what it might find. Hardcover: **$28.95**



ALMANAC OF SOVIET MANNED SPACE FLIGHT
#40 A revealing launch-by-launch chronicle of each mission with craft illustrations, dates, objectives, problems and successes. Hardcover: **$29.95**



SPACE ENTERPRISE: BEYOND NASA
#41 Outlines the parameters for the development and growth of private enterprise in space. Hardcover: **$19.95**



JOURNEY INTO SPACE
#42 The first thirty years of space exploration, the promise and frustration, success and tragic failure. Hardcover: **$19.95**



THE VIEW FROM SPACE
#43 Dramatic color photographs taken in space by 16 different astronauts from 1962-1972. Hardcover: **$24.95** Save over $5.00 off cover price!



RACE INTO SPACE: THE SOVIET SPACE PROGRAMME
#44 Recounts the thrilling and dramatic events of the Soviet programme from its earliest beginnings. Hardcover: **$41.95**



COUNTDOWN
#45 Compelling, intensely personal autobiography of former astronaut Frank Borman's career. Hardcover: **$19.95**



FOR ALL MANKIND
#46 A dramatic, engrossing and comprehensive account of man's greatest adventure—the voyage to the moon. Hardcover: **$19.95** Save $3.00 off reg. price!



JOURNEY TO THE STARS
#47 Space exploration tomorrow and beyond. The search for life on other worlds. If they are listening to us, will they reply? Hardcover: **$18.95**



BEFORE LIFT-OFF: THE MAKING OF A SPACE SHUTTLE CREW
#48 An unprecedented look at how shuttle astronauts are trained. Hardcover: **$18.50**



THE GLASS LADY
#49 A most accurate minute by minute account of flight on board the Space Shuttle. A daring mission to disable an orbiting satellite weapon. Hardcover: **$16.95**



LIFT OFF: THE STORY OF AMERICA'S ADVENTURE IN SPACE
#50 Michael Collins' account of one of mankind's greatest adventures...the US space program. Hardcover: **$21.95** Save over $3.00 off cover price.



NIGHT LAUNCH
#51 A red-hot techno thriller combines hard information with a suspenseful plot. A rescue mission in space. Hardcover: **$18.95**



THE SOVIET MANNED SPACE PROGRAM
#52 From Yuri Gagarin to Salyut 7 and Mir. Provides an unparalleled perspective. Over 200 photos. Hardcover: **$24.95**



ENTERING SPACE: AN ASTRONAUT'S ODYSSEY
#53 Joseph P. Allen's first hand account of space flight—from countdown to life in space. Over 200 photos. Hardcover **$17.98** Save $7 off cover price



MEN FROM EARTH
#54 Buzz Aldrin tells the story of America's race with the Soviets to the moon in a vivid re-creation. Hardcover: **$19.95**



PRESCRIPTION FOR DISASTER
#55 From the glory of Apollo to the betrayal of the Shuttle. A startling expose' of America's space program. Hardcover: **$13.95** Save $5.00 off cover price!



SPACE STATION FRIENDSHIP
#56 A berth has been reserved for you on the space station in the year 2007. Special autographed edition. Hardcover: **$15.95**



THE ENCYCLOPEDIA OF SOVIET SPACECRAFT
#57 Over 250 photos from Vostock (the first manned spacecraft) through Salyut. A must for space enthusiasts. Hardcover: **$14.95**



THE PICTORIAL HISTORY OF WORLD SPACECRAFT
#58 Over 200 photos from Sputnik 1 through the Shuttle, satellites and Voyagers of the 80's. Hardcover: **$17.95**



THE ENCYCLOPEDIA OF US SPACECRAFT
#59 A detailed catalog of America's spacecraft developed for commercial, military and NASA programs. Hardcover: **$14.95**

The National Space Society

and the

California Space Development Council

present the

9th Annual International

Space Development Conference

May 25-28, 1990

Anaheim, CA

- **To the Moon and Mars**
  Is this the permanent settlement of space?
- **Global Warming**
  Are solar power satellites the solution?
- **The Civilian Space Program**
  Can it create peace and prosperity?
- **Government vs. Private Industry**
  The debate that won't go away.



Enjoy the conference with:

Gene Roddenberry and the cast of *Star Trek, the Next Generation.*

James Fletcher

J.R. Thompson

Charles Walker

Rep. Ron Packard

Rep. Dana Rohrabacher

CoSponsors:

Spacecause

Final Frontier magazine

Spacepac

Space Studies Institute

US Space Foundation

World Space Foundation

Planetary Society

Civil Air Patrol

Challenger Center

SPACE DEVELOPMENT
IN THE 90's

POSSIBILITIES UNLIMITED

Detach coupon and mail today.

Yes! I'd like to attend the Space Development Conference.

Name

Address

City State Zip

( ) ( )
Day Phone Evening Phone

Mail to: **CSDC**, P. O. Box 2183, Redondo Beach, CA 90278

_____ Number of participants

☐ Check/Money order enclosed.
Make payable to the California Space Development Conference.

Amount enclosed _____

☐ Master Card ☐ VISA
☐ American Express

Account number Exp. Date

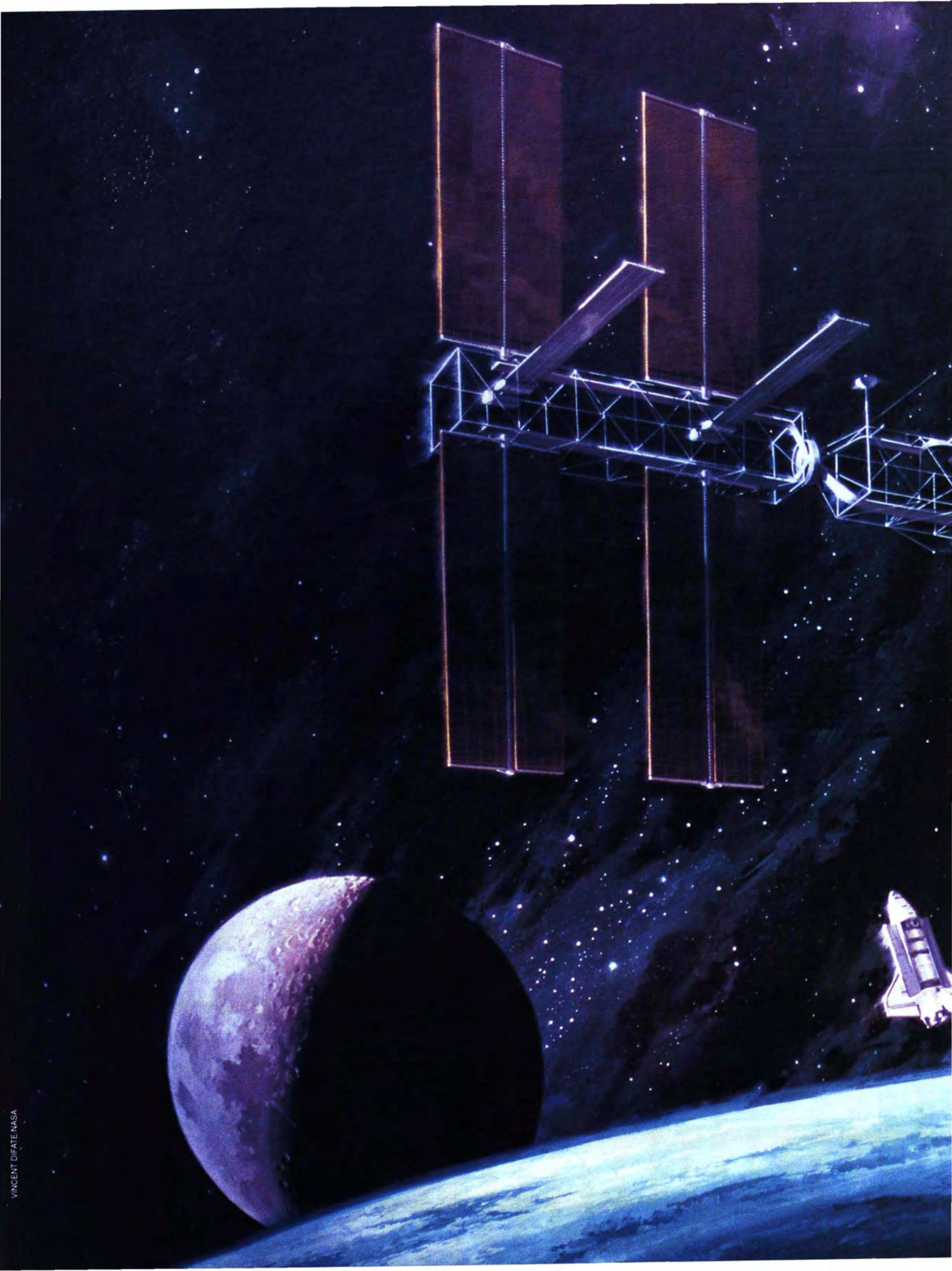
Signature Date

Registration: $55.00 before April 15. After April 15, $70., or $40. per day.

Hotel Reservations: Pan Pacific Hotel of Anaheim, CA. Next to Disneyland. Conference rates: $76/night, 1 to 4 people. In CA, call 1-800-321-8976, US & Canada call 1-800-821-8976. Outside the US call 1-714-999-0990.

American Airlines discount conference rate, 40% below normal. Call 1-800-433-1790 and give the acct no.: Star #0250K1.

For further info about the conference call NSS Headquarters at: **(202) 543-1900**.


VINCENT DIFATE NASA

ONBOARD FREEDOM: PART 2

2000-2010

We've all had the experience. You're on a two-week vacation with a friend, a close friend, but by the eighth day you find yourself at dinner fingering your steak knife and looking longingly at your companion's neck. You may have set out together to enjoy the wonders of Paris, the grandness of Vienna or the crashing waves of the Kona Coast, but now the person you liked so well so recently seems unable to move without making your skin crawl.



As trivial as it may seem, this sort of problem is a major concern for the engineers, scientists and psychologists who are tackling the issues of living and working on space station Freedom. When it comes to operating the station, humans will be the linchpin. If the crew should grow unhappy, frustrated, moody or downright ornery, efficiency will suffer and the ration-

SPACE BASE

Take eight busy people, mix at close quarters for six months at a time, then remove gravity. Welcome to the space station. By Chip Walter

Whatever their duties, all crew members must learn to work in weightlessness. Push too hard off the floor and you could catapult yourself into the ceiling.



Dining in the wardroom: As on Earth, the kitchen table will be a social hub.

ale for maintaining a permanent orbiting base will begin to look less than sensible — especially at a cost of some $30,000 per hour per crew member!

Once you accept the basic concept that human beings will work, sleep, play, socialize, exercise, wash and dress while floating around in four truck-trailer-sized cylinders, you realize how much thought must be given to keeping the crew onboard Freedom from going batty in the process. The station will be the space-age equivalent of living on a desert island. When you add the bald danger of the undertaking, the length of duty (three to six months) and the difficulty of designing a weightless environment where up and down are pretty much meaningless, you begin to appreciate what the folks at NASA call "design challenges."

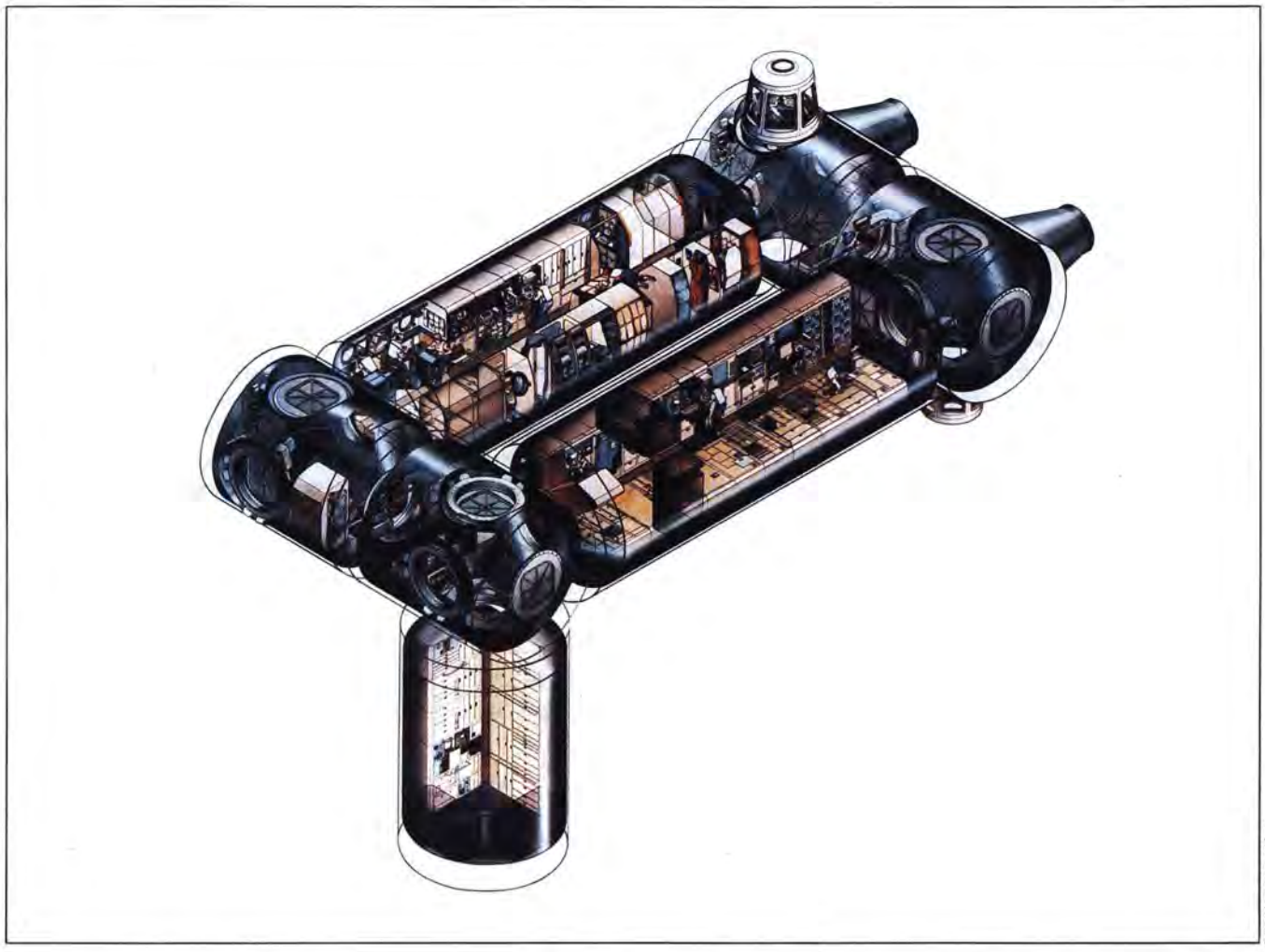
Though space stations hardly clutter the Solar System, we do have examples of what can happen when people are forced to endure dangerous or cramped situations for lengthy periods. Thanks to their Salyut and Mir space stations, Soviet cosmonauts have much more experience in long-duration flight than do American astronauts, and they know how bad such confinement can get. "We had prepared for this long and hard together, rehearsing every anticipated problem," wrote Valery Ryumin in his diary as he began a 175-day tour aboard Salyut. "But this was done in an environment of other people. Here we are totally alone. Each uttered word assumes added importance. One must bear in mind — constantly — the other's good and bad sides, anticipate his thinking, the ramifications of a wrong utterance blown out of proportion."

What few studies exist on the subject indicate these conditions can damage both social harmony and work performance. An endless list of chores and problems can complicate matters, including food preparation, cleaning clothes, injury and sickness. How will the Freedom crew respond to these challenges of life in zero-g? And what about entertainment, relaxation, personal space, communication with family and friends — or, more precisely, the lack thereof?

Imagine you're one of four members of a fresh space-station team arriving from Earth. Fittingly, it's the year 2001 and Freedom has reached what the acronym lovers call AC (Assembly Complete). Every 90 days (and then eventually every 180 days) four crew members will rotate out of the station and return home to be replaced with four new astronauts — in this case you and your team members. This ensures there will always be four veterans on the station. It also will help keep the mix of people relatively fresh.

It has taken two days since launch for the shuttle to rendezvous with Freedom. In the orbital equivalent of parallel parking, the shuttle commander maneuvers the spacecraft within reach of the station's Mobile Servicing System (MSS) — a trolley-like device that can position various robotic arms wherever needed along the station's structure. A large docking arm grabs the shuttle gently, to avoid shaking the sensitive microgravity experiments underway inside the station's three laboratory modules.

Below, clouds swirl and the planet spins



BOEING AEROSPACE

A sketch of the U.S. modules and connecting "nodes." The design allows various areas to be sealed off in the event of an accident.

as you gather your belongings and review your checklists with the team members you've been training with for a year now (all told, your mission has been in the planning for some five years). Next you board the station, which, after several days in the steamer-trunk confines of the shuttle's mid-deck, will seem palatial.

Entering through the station's starboard node (nodes are the connecting areas between the main compartments) you'll swim slightly to your left into the habitation module. Here and most everywhere else, Freedom's decor will be — there's no other way to put it — institutional: Whites and grays, fluorescent lighting, lightweight alloys and plastic will predominate. Forty-two feet long and crammed with an impressive array of electronics, the habitation module is a model of efficient packaging, further enhanced by the lack of gravity, which makes every inch of space useable and accessible.

The bottom half of the module will tend to be shaded darker than the top half, a subtle reminder of "up" and "down." The entire station will be designed with this orientation in mind. Though having breakfast on the "ceiling" might be novel, (and easily done in orbit) lacking at least a *sense* of up and down can be annoying and confusing — a complaint lodged loud and clear by several former Skylab astronauts who are now working as consultants to the Freedom project.

Your arrival marks an event worthy of celebration as members of the onboard crew gather round the wardroom table in the galley to hear the latest on earthly issues and swap a few good ol' space-age lies. No booze (unlike the Soviets who share a little brandy on similar occasions), but plenty of presents, videotapes and personal mail for the crew members who won't be departing. Like their Russian counterparts on Mir, the American, European and Japanese astronauts on Freedom will undoubtedly find these small gifts to be so many surrogate hugs and kisses from friends and relatives on the ground.

The habitation module is divided into three major sections: the galley area at one end, the crew quarters at the other, and a bath, toilet and small medical facility forming a "buffer" zone in the center.

The plans for these areas have been badly eroded by budget cuts on Capitol Hill, but designers are working to preserve as many creature comforts as possible. "The human factors of the space station are important," says space station systems manager Phillip Mongan at NASA's Johnson Space Center in Houston. "What we do is to make the everyday things — the meals, the showers, the tools, the liv-

ing quarters — as palatable as possible so it doesn't affect the mission."

Among the most important "everyday things" will be the eight private crew compartments ringing one end of the habitation module. Each will be hidden behind soundproof sliding doors in the floor, ceiling and walls. More than an orbiting bedroom, your quarters will be your inner sanctum — the psychological escape hatch to which you can retreat when it becomes impossible to stand, say, the way Francine or Jack slurps coffee through a liquid container straw.

Of all the so-called rooms on the station, you will have the most control over the way your private quarters look. You'll be able to choose from eight different interior colors. Nothing so mundane and messy as paint will be used for decorating: The walls will be draped in a pre-cut fabric that can be attached with velcro tabs or metal fasteners to the cabin's interior.

You couldn't describe the quarters as roomy — they won't be much larger than a phone booth (about 50 cubic feet) — but Mongan points out the benefit of weightlessness. "It's really amazing the extra volume you have when there's no gravity," he says. "It just opens up a dimension that you don't expect."

Even if you don't consider your personal quarters roomy, you will undoubtedly find them a cozy retreat at day's end as you float wrapped in the soft material of your sleeping restraint — the station's version of a bunk. The restraint looks a little like a sleeveless sleeping bag and will keep you from bobbing around like an untethered helium balloon. It covers one of the cubicle's walls, which leaves the other two and the ceiling available for the storage of clothes, books and video tapes (more likely laser disks by 2001). With stowage space at a premium, variety will not be the hallmark of your wardrobe; but you'll be able to wear pretty much whatever you want, from various station uniforms to jeans and flannel shirts, as long as the clothes meet safety standards.

You'll store all personal belongings in duffel bags that fit by design into spaces in the quarters' walls. As you exchange places with the previous crew, they'll simply pull their bags out, place them in a larger bag and head for the shuttle while you do the reverse. This reduces the likelihood of having a family portrait or your hardback version of *Moby Dick* float around the bend into the laboratory module and clunk a fellow scientist on the parietal lobe.

Your private compartment also holds a pullout desk. You can plug your personal computer into the station's data management system and continue work, write a best seller about life in space or blow off a little steam in your diary about Jack's slurping.

There may or may not be a window in your quarters. Budget cuts have placed these in jeopardy — they can create expensive structural problems. Also under debate: individual monitors for watching movies or television shows and for communicating privately — talking *and* seeing — via two-way videophones with friends and family. Designers are fighting hard to keep this capability for each astronaut. However, if the videophones fall to Washington's budgetary cleaver, private audio links will replace them and a single video link will be made available for the entire crew — a kind of space-station version of the old dormitory public phone.

> Tang, a few tubes of peas and reconstituted beef meal may have been okay in the Apollo era, but on a 180-day mission that diet would become a recipe for mutiny.

After a good sleep in your crew quarters, you'll want to wash up and heed the calls of nature. These are not simple undertakings in zero gravity.

Taking a shower, for instance (which you'll probably do every other day), involves entering a cylindrical enclosure that bears a startling resemblance to the orgasmatron in Woody Allen's send-up of the future, *Sleeper.* After closing a kind of revolving door, you first adjust the airflow temperature. It seems that many of us increase the shower's force and heat to keep the stall comfortably warm, essentially using hot water to heat the air around us. On the station all water must be recycled, and waste would not be appreciated.

Okay, you're warm. You grab a hand restraint (so that when you turn on the shower wand its thrust doesn't knock you into the wall) and spray yourself. Once wet, you lather up with a specially developed soap low on chemicals to simplify water purification. Remember, the water that showers you today may brew your coffee next week. Having lathered up, you grab the suction wand and vacuum the wet soap from your body and hair. Next, you towel off, then sweep up all the marble-like spheres of excess water floating around the shower. Airflow will tend to push them toward your feet, but you want to make sure you get every one of the little devils. If any escape and bounce into a fancy piece of electronics, they could short-circuit an entire system.

Next to the shower is a place to comb or curl or set your hair, shave and generally attend to your appearance. There is also the toilet — a vacuum-operated affair — that, without going into a lot of unsavory detail, will essentially use air and suction the way a normal toilet uses water. Most astronauts agree that going to the bathroom in space is an unforgettable, occasionally harrowing experience, and no one expects this to change on the space station.

This central "buffer" zone also contains the station's medical facility: the Crew Health Care System (CHECS), which designers characterize as a "sophisticated first aid station." CHECS will be able to handle minor surgery, burn treatment, broken bones and various standard human ailments. No major surgery will be performed here (tough to do in zero gravity), but NASA hopes that even serious injuries can be stabilized until the afflicted astronaut is returned to Earth for treatment. At least one member of each crew will be trained as a medic to handle the ill and injured, and, if necessary, they will receive instruction from experts on Earth using a video uplink.

The other major facilities in the

center of the hab module are a drinking fountain (similar to a squirt gun) and a hand-washing unit. To call it a sink would be a misnomer. Those pesky water drops once again pose a problem, and to contain them you'll slip your forearms through holes with rubber grommets (like the ones that separate the kitchen sink drain from the garbage disposal), scrub up, rinse off and vacuum whatever remains.

The exercise area may also be nearby, or it may be placed in one of the connecting nodes to reduce noise and save room in the main hab module. Exercising is a crucial issue in space. It turns out that human interaction with gravity — the force that makes it hard to climb stairs and lug grocery bags — is essential to life. When gravity is absent, the body's blood distributes itself where it likes, but not necessarily where it is needed. Bone, which no longer has to support the body's weight, ceases to manufacture calcium. Unsummoned by the muscles to supply the nutrients they formerly needed to fight gravity, the heart grows weak.

There will really be two places to exercise on the station: this general facility for staying in shape, and another for measuring fitness and other vital functions, including bone demineralization, located in the U.S. laboratory module. In both cases, designers are leaning toward bicycles, rowing machines and some sort of variable resistance device — a contraption perhaps similar but a bit more sophisticated than the one Skylab astronaut Ed Gibson rigged from Teflon pads and bungee cords.

The galley and wardroom will be the noisiest section of the habitation module and therefore farthest from the crew quarters. Plans for the galley are constantly changing, but all designers agree on the psychological importance of good food. Tang, a few tubes of peas and reconstituted beef meal may have been okay in the Apollo era with its tough "right stuff" astronauts; but on a 180-day mission that diet would become a recipe for mutiny.

"We'd like astronauts to be able to sit down with real silverware, and eat some good green beans and roast beef or brisket and good potatoes, not something where they feel they're camping," says Mongan.

Then there are the culinary preferences of an international crew to consider. Hamburgers are not likely to go down well with the French or Japanese — or Americans for that matter — day after day. So NASA, which is responsible for supplying all the crew's nourishment, is working on ways to provide a variety of food that may even take personal preferences into account. NASA is also playing with new techniques that remove oxygen from packages of fruit and vegetables so they will remain "fresh" for weeks or even months. Mongan says health is another consideration. "You want to keep processed food to a minimum because it's usually loaded with salts and fats."

continued on page 58

A Day in the Life

Everybody on Freedom will be operating on different and rather precise schedules. It's the only way to assure the most efficient use of the station's limited power, room and resources.

For scheduling purposes, the station's crew members will be divided into two teams of four. One team will be active for 12 hours while the other sleeps or relaxes. Both teams will work six days a week and all crew members will share a common day off. This free day will give the crew a chance to socialize and, frankly, take a break from the people with whom they usually spend so much time. There won't be any reveille, but the days will be busy and crew members will need to be disciplined. Let's say you're a station scientist working in one of the lab modules and you've pulled the "daylight" schedule—if such an earthbound term can be used. Here's how a typical shift might go (based on preliminary plans):

7 am—Rise and shine and take 20 minutes to half an hour to wash up, brush your teeth, shave, blow dry, curl, dress...generally make yourself presentable for the day.

7:30 am—Float down to the galley, draw (no such thing as pour) yourself a cup of coffee, maybe whip up a little sausage and eggs or, if you're lucky, grab a package of fresh fruit or, if you're French, help yourself to a croissant and jam.

8 am—Meet in the wardroom with the crew member you're replacing from the previous shift.

8:30 am—Arrive at your station in the lab module. You spend the next three hours tending to the morning's series of scientific experiments.

Noon—To the exercise area; put in an hour on various tiring devices, then take a quick shower.

1 pm—Lunch. Most likely a sandwich or salad or soup.

2 pm—Back to work in the lab module (and no gawking at the sights from the cupolas).

6 pm—Another hour of exercise.

7 pm—Check out the lab, make certain all is in proper working order. If you happen to be the station operator, maybe you'll hold a press conference with the media on Earth.

8 pm—Shift change. Talk over the day's work with your counterpart as he or she returns to duty.

8:30 pm—Free time.

9 pm—Dinner and personal time. Read, watch a movie, chat, call home.

11 pm—Sleep...under the stars.

60 Ways to Leave Your Planet

Dani Eder is making a little list. By W. Dan Leonard



Microwave-Ion Rockets. Buoyant Scramjet Guns. Planetary Flybys. Hydrogen Tunnels. Launch Loops. Towers. Flingers.

Catalyzed Fusion Rockets, Atmospheric Lasers, Orbital Tethers and Momentum Exchangers. Rocket-Fed Gas Guns, Railguns, Photon Rockets and Solar Lightsails.

Dani Eder wants you to know there's **more than one way to leave the planet,** whether you're headed for Earth orbit or the stars. In fact, there are 61 ways, by his latest count.

"We went to the Moon with chemical rockets because Wernher von Braun was the best salesman and he could get us there the fastest," says Eder. "Other 1960s technology could have done it just as well."

Eder points to artillery gun launches and hypersonic aircraft as examples of alternative technologies that were all but ignored in our rush to the Moon. Once Atlas and Titan and Saturn rockets were picked as the vehicles of choice, they blasted competing space propulsion technologies into obscurity, because no one wanted to halt the progress being made with chemical-fueled rockets. We are now paying the price, says Eder, because chemical rockets are a mature technology with little opportunity for cost-cutting.

Say, for example, you're just trying to get your overworked, over-budget satellite 300 miles overhead for under $4,000 a pound. Eder would like to be able to offer you a ride in the cargo bay of an artillery rocket, compressed gas gun, aerospace plane or just about any of the other vehicles on his list.

"It's time to cut our losses," he says, "and start seriously developing alternate technologies and exploiting the technology that's already around." Eder hopes his "Technology Inventory for Space Development" will be used as a tool to do just that.

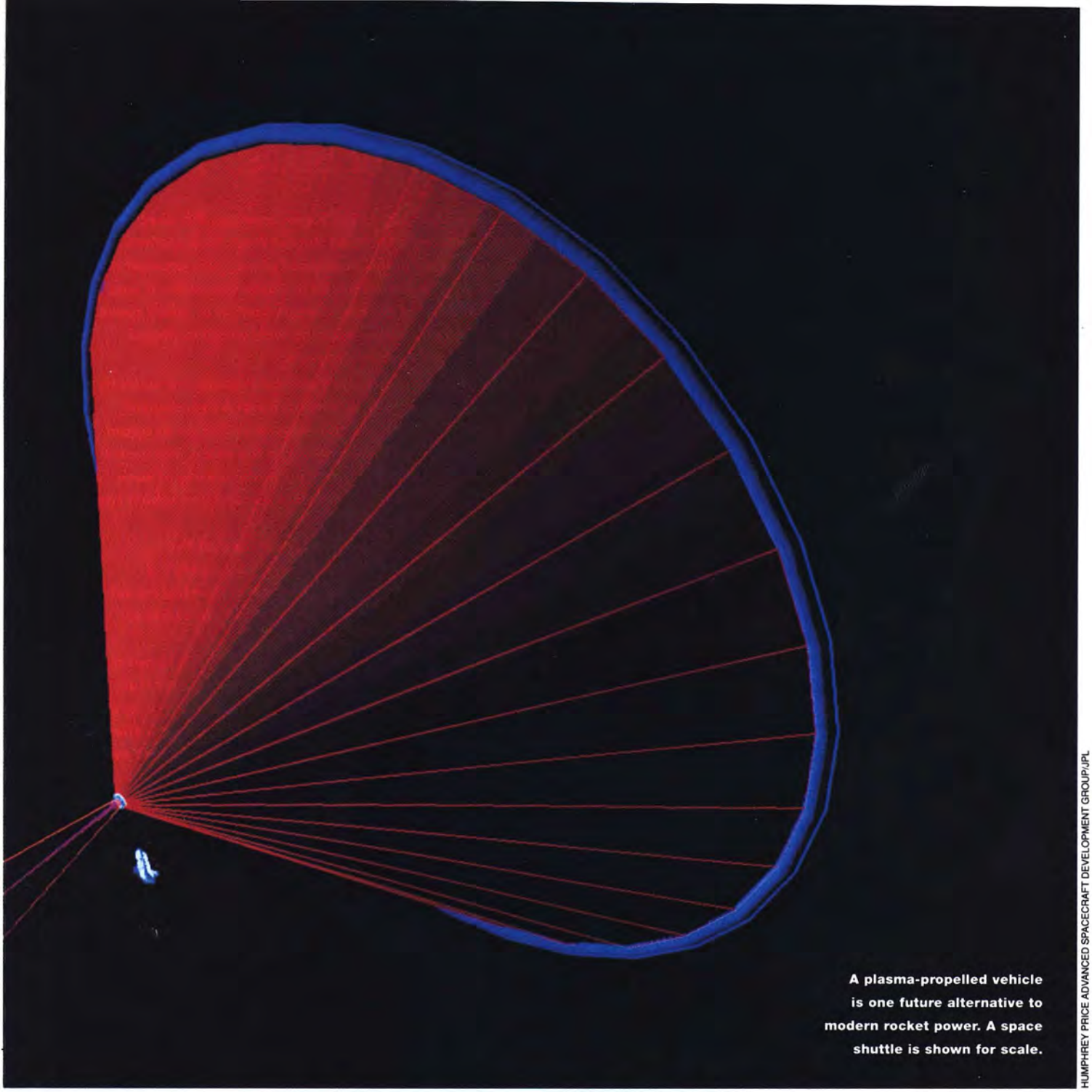
The 31-year-old analyst with Boeing's Advanced Civil Space Group in Huntsville, Alabama, developed the list on his own time, and is careful to point out that it is *not* an official Boeing document — even though eight years working with propulsion systems and in the company's space station office served Eder well in creating it.

The inventory had its origin two years ago, when Oasis, a space activist group in California, enlisted Eder's help in listing all known concepts for space propulsion. He started with the considerable amount of information he already had in his own files. Then came literature searches, conversations with colleagues and an occasional serendipitous new "find." "Knowing a document exists is half the battle," says Eder.

In its current form the list includes a brief description of each concept and the key technologies involved. Eventually, Eder would like to have for each entry an illustration, a breakdown of subsystems, a mathematical model of performance and a discussion of operational constraints. Only after some solid engineering is done on each concept, he says, will it be possible to evaluate the competing technologies and proceed with the most cost-effective system.

"What we need to do is get down to the engineering to find out" which ones are most promising, he says. As a means to that end, Eder has included more than 90 technical references for interested engineers and scientists to find out more about each idea.

Far from a mere wish list, nearly 75 percent of the concepts in the inventory are based on current technologies. Some are already in use for other purposes, but could be adapted to space propulsion, given the proper funding. Two-stage artillery shells, for example, are capable of reaching two-thirds of the velocity needed to reach orbit from Earth. Eder calculates



A plasma-propelled vehicle is one future alternative to modern rocket power. A space shuttle is shown for scale.

HUMPHREY PRICE ADVANCED SPACECRAFT DEVELOPMENT GROUP/JPL

that an artillery shell with a rocket-assisted third stage could put a 100-pound payload into orbit for millions of dollars less than a chemical rocket booster.

Other concepts, such as the laser lightsail or the leveraged catapult, are within the bounds of today's technology, but have yet to be built. Somewhere in between are 16 concepts at various stages of development, including the NERVA nuclear rocket that underwent actual engine testing in the 1960s, and electromagnetic launchers, which are charging ahead at Sandia National Laboratories, Eglin Air Force Base and elsewhere ("Have Guns, Will Travel," January/February 1990).

In addition to grouping the concepts by their level of technical maturity, Eder organizes them according to their required energy sources: chemical fuel, radioactivity, nuclear energy, electricity, microwaves, lasers, sunlight, antimatter, compressed gas and potential or kinetic energy.

The concepts also are grouped according to different reaction methods, including exhaust (ranging from heated gas to photons), electromagnetic acceleration, gas expansion and various types of mechanical work. Eder believes that, just as earthly forms of transportation have been narrowed down to one or two optimal reaction methods and two or three principal energy sources for each environment (land, sea and air), so will space transportation.

Most of Eder's Earth-to-orbit concepts leave their energy sources on the ground. This is no accident. Chemical rockets use 90 percent of their fuel lifting the rest off the launch pad.

In the future, Eder says, payloads will be fired into space from powerful guns capable of accelerating small cargoes to orbital speeds. The mass driver and artillery concept could be fully operational for less than the cost of a few shuttle launches, he claims.

Of course, humans could never withstand the high acceleration of a gun-launch. So Eder predicts a laser beam may one day be the ticket for sending passengers into orbit. The laser rocket engine would expel hydrogen gas heated by a ground-based laser that would be focused continuously on the rocket as it rose into space.

Eder also strongly endorses the orbital tether, a 200-mile-long, high-strength rope that would rotate slowly in orbit, causing its two ends to alternate between near-Earth altitude and orbital altitude. Payloads could use a variety of means to reach a tether end during its low pass, then use the momentum of the tether to catch a ride into orbit. Materials for such a tether would have to be approximately twice as strong as the best materials available today.

Eder likes the orbital tether because of its simplicity and its flexibility in assisting other types of spacecraft. "Unlike other concepts," he says, "the tether is not an all-or-nothing prospect. If it only saves you 10 percent of your fuel, so what? That's 10 percent saved. Why not use it?"

Eder would if he were calling the shots. "If it were up to me," he says, "I would immediately build an artillery launcher or a gas gun for cargo, then I'd start working on an orbital tether."

As for interstellar travel, Eder includes mostly the standard fare of starflight literature—hydrogen-scooping ramjets, antimatter rockets and nuclear fusion rockets. His own choice would be the antimatter rocket, which would get its energy from the mutual annihilation of protons and antiprotons.

Although critics of antimatter rockets say the fuel source is too rare and expensive for the concept ever to be feasible, Eder says they are being misled. Particle physicists only capture a few antiprotons at a time because that's all they need for their research. Eder says they could easily nab a million times more antiparticles if they wanted. That's still nowhere near the amount needed for an antimatter rocket, but it is much more than people

WE CAN REACH THE STARS!


SAENGER ARCHIVE

On September 20, 1956, Eugen Saenger, the director of West Germany's Stuttgart Rocket Propulsion Institute and the father of the aerospace plane, was granted an audience with Pope Pius XII in Castle Gandolfo. It was the high point of his life, the culmination of years spent conceiving propulsion systems with which to propel mankind into interstellar space.

The following day the Pope addressed the seventh annual meeting of the International Astronautical Federation (IAF) in Rome. "Some of you have gone so far as to examine the theoretical possibilities of our traveling to the stars. We won't refer to details, but one must be aware that an undertaking of such dimensions encompasses intellectual and moral dimensions which cannot be foreseen."

The Pope referred to a paper Saenger had presented at the Congress: "On the Attainability of the Fixed Stars." By applying Einstein's special theory of relativity to a hypothetical starship traveling at the speed of light, Saenger concluded that it was possible to cross the Universe in a single human lifetime.

Saenger had closed his presentation with these words: "It is not true that we can only reach the stars in many generations...It is not true that we cannot reach galaxies hundreds of thousands of light-years away because of our limited lifetime. We do not have to resign. The infinite Universe is small enough that it is accessible to the efforts of each and every one of us...."

Saenger's premise, that clocks onboard a ship traveling at near light speed would slow down due to the "time dilation" effects of relativity, led him to calculate the passage of time as perceived by a crew on an interstellar voyage.

According to classical physics, even a perfectly efficient rocket traveling at the speed of light would require 4.3 years to reach Proxima Centauri (the nearest star to our Sun) and 30,000 years to reach the center of the Milky Way. But by applying Einstein's special theory of relativity, which makes perceptions of space and time dependent on the observer's relative motion, Saenger calculated that a starship crew would "age" only 25 years on a voyage to the Andromeda Galaxy, a distance of some two million light years. If they continued onward, the travelers could reach the edge of the known Universe within 40 of their time-dilated years. The only snag was that if they returned to Earth, some three billion terrestrial years would have passed.

Although this argument was not new to theoretical physics even in the 1950s, many scientists and engineers still are uncomfortable with Saenger's claim. In 1958, the Nobel Prize-winning physicist Max Born only reluctantly agreed that the calculations were correct, "a victory of intellect over reason."

To this day, Saenger's statement that humans can cross the Universe elicits both admiration and controversy. Engineers point to the monumental problems of propelling and navigating a starship at anything approaching the speed of light. But in Rome, Saenger had quoted Einstein's phrase "God is crafty, but not malicious," and had argued

that there was at least nothing in physics to prohibit us from traveling to the stars. A year later Sputnik ushered in the Space Age, and in the race to reach the Moon, Saenger and his challenge were forgotten.

Born in 1905 in the former Kingdom of Bohemia, Saenger had dedicated his life to developing propulsion systems for the conquest of space. In the 1930s he drew up the first designs for an aerospace plane, a rocket bomber that would circumnavigate the Earth by skipping off the outer atmosphere, like a stone thrown across a pond.

Convinced that the route to space lay in high rocket-exhaust velocities, Saenger methodically charted the potential energy from every conceivable reaction. In 1953 he caught the attention of the scientific world by proposing "photon engines," fueled by the reaction of matter and antimatter, as the endpoint to which rockets would evolve.

Whether it ever will be possible to build a vehicle capable of achieving near-light speed remains unclear. Although physicists regularly accelerate subatomic particles at close to light speed, today's chemical rockets have exhaust velocities in the range of 2.7 miles per second; light travels at 186,000 miles per second. Many scientists remain convinced that the infinite increase in mass as we accelerate to light speed (another consequence of Einstein's special theory), not to mention the impact of interstellar particles at those speeds, will prohibit us from ever building Saenger's starship.

Undaunted by his critics and encouraged by the Pope's sanction, Saenger produced a host of papers from 1956 to 1959 in which he tried to work out the technical details of the photon engine. Meanwhile, he continued to think about the human experience of starflight. His 1958 description of a journey to another star reads like something written for *2001: A Space Odyssey*.

"As the vehicle accelerates, the crew will observe a Doppler color shift in the stars they are traveling to. While their target star changes from yellow through green, blue, violet to ultraviolet, the color of their homeward sun will go from yellow to orange, and red to infrared."

In a personal appraisal of Saenger's work in 1965, Wernher von Braun commented: "Saenger's hypothetical starship with exhaust velocities at the speed of light which can travel millions of light years to the ends of our Universe is one of his most important works. With undisputable logic he shows therein the infinite possibilities of spaceflight and the vast technological and scientific challenge for Man of the cosmic age."

Saenger's final honor was his 1963 appointment to head Europe's first space faculty at the University of Berlin. It was a short hurrah. He died of a heart attack on February 10, 1964, while working on a predecessor of Germany's present space plane. In 1986 Germany would rediscover Saenger's work and name the vehicle after him.

While today's advanced thinkers speculate about colonizing space in "generation ships" that would take thousands of years to reach even nearby stars, the question Saenger raised in Rome 33 years ago remains the ultimate of quests. Can we or can we not cross the interstellar void?

According to Greek myth, Man awoke from ignorance when Prometheus stole fire from the gods. Saenger believed that it was time for a new Promethean to challenge the gods again so that we might finally venture out into the Universe. —Helmut Muller

realize, he says.

With this myriad of options, why are we still saddled to our falling star — the space shuttle? Because, Eder says, the space community cannot or will not shake itself free from the economic and political influences of the past. To break out of our dependence on chemical rockets will require a fundamental change in the way space industry is run, he says. The crucial step is scaling down the size of space projects — using 20 smaller shuttles in place of 4 big ones, for example.

Eder claims this system would be much more efficient to operate and would provide more incentive to try new technology. Since the time required to design a smaller vehicle is shorter, engineers would have a better opportunity to keep up with advances in technology. Also, since there would be more vehicles, the risk of losing one as a result of unproven technology would not be prohibitive.

As for Eder, he continues to look out for new technologies to add to his list, which he says is somewhere between a draft and a "disorganized set of notes." He figures there are probably half a dozen or so ideas out there right now that could be added, and he continues to distribute the list at conferences and technical meetings, soliciting criticisms and additions. Any idea, however far from current reality, is welcome. "My only criterion for inclusion is that it be within the understanding of today's physics," he says, which leaves out "warp drive" and other science-fiction magic.

Which of the ideas on Eder's list will open up the space frontier? "One of the things I have learned is that there's no single best answer," he says. But he's encouraged by a new openness among planners in NASA, the National Space Council and other organizations to the whole idea of getting advanced propulsion off the drawing board and into space.

"Right now there's a tremendous window of opportunity," he says. □

Copies of Eder's study can be obtained by writing Dani Eder, 1075 Dockside Drive #905, Huntsville, AL 35824. A $5.00 donation is requested to cover copying and mailing costs.

W. Dan Leonard is a Chicago-based freelance writer specializing in space and high technology.

An Astronaut ir

A well-known American space walker tours the Soviet Union, hangs out with cosmonauts and takes a spin on the "space motorcycle."

By George D. "Pinky" Nelson



Midway through my 10-day trip to the Soviet Union last fall, I came upon a simple stone monument commemorating the launch of Sputnik 1. The monument, which was built by the workers at the site on their own time, is almost hidden in a small grove of trees on the grounds of Baikonur, the Soviet space launch complex in central Asia. Gherman Titov, the second Russian to orbit the Earth, was standing with a few others beside me, in the shadow of the launch pad that first put a man-made object into space. The Soviets still use the pad, and many of the leaves above us were scorched from a recent launch.

I couldn't help but recall myself as a seven-year-old boy in Galesburg, Illinois, whose imagination was captured forever as I watched Sputnik pass over my house. I remembered the excitement I felt reading about the events of the early space programs. I made no distinction between Soviet and American missions. They were all fantastic achievements that I wanted to be a part of. And now here I was, where it all started — my own version of a pilgrimage to Mecca.

I returned from the Soviet Union with a new firsthand knowledge of that country's space program. Our delegation was shown a lot, probably more than a cosmonaut would see on a similar trip to the United States. With cameras in hand, we actually walked out on the "integration floor" where the Soviets assemble their Proton and Energia boosters. I also visited the factory where they design their ejection seats and spacesuits. I put on the Russian spacesuit and made a short "test flight" of their version of the MMU, or manned maneuvering unit — what the Soviets fondly call their "space motorcycle."

It was quite a trip.

And yet it was also a little depressing. The Soviets are taking Glasnost seriously, but part of their new openness is the result of what I sense is almost desperation. The Soviet space program is finally faced with justifying its existence to the politicians and the people — something the American program has been doing all along. With so few consumer goods available to the average Soviet citizen, it is not surprising that many would rather see the money now spent on the highly visible space program directed toward programs perceived to be more closely associated with the public good. Sound familiar?

I went to the Soviet Union as part of the American delegation attending the Eighth Man in Space Symposium sponsored by the International Academy of Astronautics (IAA). The conference, held in Tashkent, dealt mainly with biomedical and physiological problems related to spaceflight. It was hosted by Anatoli Grigoriev, head of the Institute for Biomedical Problems, the unit in charge of space medical research and maintaining the cosmonauts' health.

Although I'm not a doctor, I am interested in the effects of spaceflight on the human body and the interaction between flight crews and medical researchers. I was also curious about the data that would be presented by the Russians from their long flights aboard the Mir space station.

Our seven-person delegation was headed by Dr. Arnauld Nicogossian, head of NASA's Life Science Division, who has maintained a cooperative program with the Soviets since 1971. The group included several American space officials and two others besides myself who had space shuttle experience: Dutch payload specialist Wubbo Ockels, who is helping to plan the Hermes space plane and Columbus space station module for the European Space Agency, and former U.S. astronaut John Fabian. John has developed a rapport with Soviet cosmonauts as an officer in the Association of Space Explorers, and was instrumental in arranging my "test drive" of the Soviet MMU.

A highlight of the conference was a report describing the health of cosmonauts Musa Manarov and Vladimir Titov after they had spent one year aboard Mir in 1988. Thanks to a rigorous exercise pro-

n Baikonur





Left: Nelson (middle row, left) on the pad at Baikonur. Gherman Titov, second Soviet to orbit Earth, is the general on the left. Above: Nelson tests a launch couch.

gram consisting of two one-hour sessions every day, they returned to Earth in excellent condition. That doesn't mean they were totally normal. It took a day or so before they could walk, and five days for their hearts to grow back to preflight size and strength. But they recovered quickly and fully. The amount of calcium lost from their bones was large enough to measure but not enough to effect bone strength or threaten their future health.

These results led the Russians to conclude that a crew's physical health will not be a constraint on a flight to Mars. They plan to further expand their database in the near future with an 18-month mission aboard the newly expanded Mir.

It made me more than a little jealous to hear stories from my Soviet counterparts who've spent more weeks in space than I have days. They returned the favor, listening as we Americans talked about performing space walks and flying our MMU. Space walks are one of the carrots dangled in front of the cosmonauts to help maintain their morale during long missions onboard their relatively small station. It's always nice to take a walk outside when you've been cooped up in the house for a long time, and the next month or so is easier to bear if you know a space walk is coming up.

There were four cosmonauts at the conference, including Valery Polyakov, a medical doctor who flew for eight months on Mir conducting experiments in conditioning and medicine. Polyakov had helped develop the exercise routines and presented the medical results at the conference. Georgy Grechko, the gregarious veteran of three missions, is now a space scientist. Valery Kubasov last flew in 1975 on the Apollo Soyuz mission. Vladimir Dzhanibekov, the John Young of the Soviet program with five flights to his credit, is now the head of cosmonaut training in Star City.

By Sunday it was time for a little exploring, and our group took a bus trip to Sammarkant, an ancient city and popular tourist stop. While standing outside the bus near a market, a big black Lada limousine pulled up with Polyakov and Kubasov inside. In their best English — which is infinitely better than my Russian — the cosmonauts explained that I should ride with them to a square where a film was being made, so we could be interviewed by the film maker. I climbed in and off we went.

The driver was very proud of his limo. It must have weighed three tons and had an automatic transmission, which I gathered is rare in Russia. Big black limos don't need to obey traffic laws like everyone else. We eased through red lights and down one-way streets the wrong way, politely moving traffic to the side.

The movie turned out to be a science thriller. We were interviewed while standing beside the leading man and his family. He was playing a space pilot. We repeated the theme that there should be more cooperation between the United States and the Soviet Union for our mutual benefit.

The relationship between the cosmonauts and the Soviet public is different from the one we know as astronauts in the United States. Unlike America, where astronauts are admired as a group but not so much as individuals anymore, the cosmonauts are still individual heros. Even so, as more and more Soviets fly, the public's ability to remember them all is being taxed. Some of the newer cosmonauts had to introduce themselves before they were recognized. There is no doubt that the cosmonauts are held in the highest regard as Heros of the Soviet Union; and yet at the same time their dealings with the people are on a personal and casual level.

After the interview we went back to the market, then down a side street into a residential part of Sammarkant. We passed a group of men standing outside a noisy doorway. I'm not sure if they recognized the cosmonauts or if it came up in conversation, but somehow we ended up inside the courtyard of the house in the middle of a bachelor party for a Moslem wedding. There was traditional music, food and toasts to the groom, the house, space, world peace.... Later we ended up at the home of one of the film crew for yet another dinner and another round of toasts. We

found the buses again and I had a good sleep on the way back to Tashkent.

Early the next morning a small group boarded the bus for a ride to a military airport — our first leg in the journey to Baikonur, the Soviet launch complex. I still get excited when I fly to Cape Canaveral, so you can imagine how I felt at the prospect of touring Baikonur! Our small group climbed into the back of a twin turboprop military transport — a typical paratroopers' platform in the rear, with only two passenger seats in the front. The rest of us sat on the benches that lined the fuselage. The plane took off, circled Tashkent, re-entered the pattern and landed. I figured the plane was broken and our trip would be cancelled.

We taxied back, the cargo door opened and in climbed a smiling Dzhanibekov. Our host from Star City had overslept and missed the plane! Evidently, an air force general has equal privileges whether his uniform bears a red star or the stars and stripes. A call on the radio was all it took to turn us around. We were glad to have Dzhanibekov, who we called "Johnny," onboard since he knows as much about the program as anyone. He's also fun and personable.

The noisy flight to Baikonur took about two hours. We passed the time watching the featureless desert pass underneath us and taking turns in the copilot's seat. Soviet transports, even this small one, have four-man crews, so it was crowded in the cockpit. We landed on the long runway that serves Leninsk, the town where the 90,000 people who support the launch operations live.

We were first met at the plane by Gherman Titov, the former cosmonaut who in 1961 became the second Russian to orbit the Earth. He is now a three-star general in the Soviet Air Force, in charge of the site's launch facilities. With him was one-star general Alexei Shumelin, who has been the equivalent of the launch director since the late 1950s.

We boarded a bus and headed east past Leninsk toward the launch complex. As we drove for miles, passing a large liquid-oxygen factory and radio dishes used for launch communications and tracking, we began to suspect that we would only be allowed to see what was visible from the road. After nearly 20 miles the bus turned north and we drove to the launch pad used for the Proton booster. In retrospect, the drive was about the same distance as that from Cape Canaveral's Patrick Air Force Base to the launch pads at the Kennedy Space Center.

The security around the pad itself was less evident than at the Cape, probably because we were already in a very isolated spot in the middle of the desert. There are no tour buses at Baikonur — it's a long way to Disney World.

On the launch pad we got off the bus and walked up to the gantry. General Shumelin described the pad's systems and structure. It's a simple yet elegant design that has worked for years. That is one theme of the Soviet program: When a design works they don't change it. This launch pad was not only the same design as the pad that launched Sputnik 1; it *was* the launch pad that launched Sputnik 1. The same hardware that worked for Sputnik was still being used to launch both manned and unmanned Soviet rockets.

Dzhanibekov himself had flown three times from this pad. His other two flights were from the other Proton pad, which is a carbon copy. There were red stars painted on the gantry — three large stars and a few smaller ones. When we asked if they denoted significant missions launched from the pad, they said no, the stars signified the number of flights launched: 317 from 1957 to 1989. At the base of the pad, in the grove of trees, was the small stone monument to Sputnik 1, the first of those launches.

We went from the launch pad to the Proton rocket processing and integration building. We even ventured out onto the floor where the booster for the next launch, a resupply flight to the Mir space station, was being assembled. The rocket stages lay on their sides, on trailers on the floor, while a Progress resupply capsule and a Soyuz manned capsule stood in vertical stands on each side of the room.

Unlike its American counterpart, The Soviet "space motorcycle" is operated with two separate hand controls.



NOVOSTI

The workers had been cleared from the room; we could see them watching us as we wandered around. I knew what they were thinking: "Don't touch anything, that's my rocket!" I know the workers at the Cape feel the same way when the astronauts come through to inspect the hardware. After all, the spacecraft spends most of its time on the ground. We "borrow" it for a mission and try to bring it back without breaking anything.

At one point, I asked about the small rockets used to steer the rocket during launch. The main engines are fixed, always pointing in the same direction, whereas space shuttle engines "gimbal" to steer the vehicle. One of our guides reached out and grabbed the nozzle, wagging it back and forth to show me how it moved. I pushed my hands deeper into my pockets and winced. I guess the Proton has been around long enough and is simple and robust enough to take that kind of abuse. The shuttle isn't.

From the Proton building we took the bus to the building where they assemble the giant Energia booster and the Soviet space shuttle, Buran. The Soviets put their rockets together lying on their sides — called horizontal integration — while Americans assemble their rockets vertically. Each method has its advantages and disadvantages. For a rocket the size and complexity of the Energia, horizontal assembly seems more difficult to me.

The Energia is designed to boost either large payloads or the Buran shuttle, so all the engines have to be on the booster system. As a consequence, the engines are thrown away on each flight. In the assembly building we saw enough hardware to build three or four rockets, plus four Burans. Only two of the shuttles were spaceworthy; the other two were test articles similar to the Enterprise used by NASA for landing tests in the 1970s and the full-scale shuttle model on display in Huntsville, Alabama.

The Energia launch pad is huge, about the same scale as pads 39A&B at Cape Canaveral, which were built for the Saturn

5 and modified for the space shuttle. Even though the next launch of the Energia isn't scheduled until 1991, there was a test vehicle on the pad. Looking at Energia's complex plumbing and electronics, my impression was that the Soviets have bought into a vehicle as complicated as the shuttle, along with the problems associated with operating it.

Even within the Soviet space program, there is a vigorous debate over the value of the Energia and Buran in light of their enormous cost and complexity. Time will tell the usefulness of the vehicles. Still, one of the workers who was showing us around pointed up at the monstrous vehicle and said, "There is the launch pad that will send the first men to Mars."

Back at the village near the Proton pad we were given a tour of the small houses where the cosmonauts used to stay for a few days just before their launches. The houses have been restored now, one with the artifacts of Yuri Gagarin and the early cosmonauts, the other with the things of Korolev, the Soviet Wernher von Braun. Titov was careful to note the spartan conditions in which he and the other early cosmonauts lived, compared to their current quarters in Leninsk.

I couldn't help but recall our old astronaut quarantine quarters in Houston — those decrepit house trailers inside a poorly heated and cooled warehouse where we spent four days prior to flying to the Cape. In comparison, the small three-room houses with kitchens and offices used by the Soviets looked pretty good. Since the Challenger accident the astronauts have moved into new crew quarters in Houston that are quiet and comfortable and, from what I could gather, similar to those the cosmonauts now use.

We returned to Tashkent on the same aircraft, arriving in time to attend the closing banquet of the symposium. Early the next morning, John Fabian, Georgy Grechko and I flew back to Moscow for a visit to the Zvezda (Star) factory where the Soviet space suit is designed and built. Our host was Guy Severin, the head of the factory and chief designer of the space suit and the Soviet MMU — the so-called space motorcycle. This was the one location on our trip where we weren't allowed to use cameras.

One purpose of the visit was to get



REUTERS/BETTMANN NEWSPHOTOS

Soviet Cosmonaut Alexander Viktorenko and the space motorcycle in action: February 1990.

our evaluation of the space motorcycle, which was designed in the Zvezda factory. It is currently onboard the Mir and was flown successfully by the crew in February. The Soviets were interested in hearing my opinions since I had flown our own MMU during the Solar Maximum repair mission in 1984.

Having no experience in either the Soviet space suit or their MMU, I got a 30-minute briefing on the MMU's systems, displays and controls and a very short rundown on the suit. The "flight" was to be on an air-bearing floor, a smooth, flat metal surface over which the MMU glides on a very thin cushion of air blown through four circular pads. The floor was about ten meters on a side. On the floor, waiting for me, was the space suit mounted in the MMU, the entire unit supported on a stand with the air-bearing pads.

Once in the suit, I could fly the MMU in two dimensions (instead of three) around the floor using the jets on the MMU for thrust. The task was to fly the vehicle using its various control modes, with and without a tether. Unlike Bruce McCandless' first flight from the shuttle, the first MMU flights from the Mir were tethered. The reason is that the shuttle has the ability to fly after an errant astronaut while Mir can't be maneuvered for a rescue.

I changed into long underwear and climbed into the suit. The life-support backpack on the Soviet spacesuit swings out like a back door. Instead of pulling on the pants and "swimming" up into the vest like we do with the NASA suit, the Soviet suit is one piece. You climb in the back and drop your feet into the leg holes, reaching your arms into the suit arms and ducking your head into the helmet.

Inside the suit I felt a little claustrophobic, probably because the suit was unfamiliar (I didn't know how to get myself out in a hurry) and the field of view through the faceplate was more restricted. Once the suit was zipped up and pressurized I felt more comfortable. Even at the roughly 50 percent higher pressure used in the Soviet suit, the mobility was good and the gloves adequate for flying the MMU. The Soviet gloves are technically more like our Apollo gloves than those used on the shuttle, which fit more snugly and are less stiff.

It felt good to be back in a spacesuit again, though, and I started "flying" across the floor, easing away from the edge.

When connected to the tether, it was necessary to face the attach point all the time or risk getting tangled. The first actual flight of the MMU onboard Mir involved backing straight away from the hatch and using the tether to reel the crewman in. The size of the thrusters on the Soviet MMU are almost the same as those on the U.S. version, so the response to control inputs seemed normal.

There were two main differences, though. The first was in the controls. Their version had two separate controls: one for motions forward and back, and one for the other directions (up, down, left, right). The U.S. MMU has all these functions on the same handle. If you want to go forward you push the handle forward. If you want to go up you push the handle up, etc. The different designs reflect the way the controls in the Soyuz and the shuttle are built.

I found it awkward that I had to change controls in order to move in different directions. If there were a malfunction — say a stuck-on jet — you might need to use both handles simultaneously to maintain control.

The second main difference was in the basic control mode. The U.S. MMU uses a simple system. When the control handle is moved, jets come on. When the handle is released, the jets stop and the MMU coasts with whatever motions have been put in. There is also a mode that will stop rotations and hold you still. This is engaged

continued on page 63

Radical Fringe

continued from page 30

Assemblers

The magnificence of his vision fits the grandeur of the setting: great transparent sailing ships, hundreds of miles long, riding a laser beam across the interstellar void at nearly the speed of light. The precious cargo would be world-building robots the size of bacteria.

Welcome to the tomorrows of K. Eric Drexler, who wants to make use of the unimaginably small to explore the unimaginably vast.

Drexler, author of the 1986 book *Engines of Creation: The Coming Era of Nanotechnology,* is the world's leading theorist in the field of nanotechnology, whereby computers and robots are assembled atom-by-atom, and are so small that thousands of them could be placed within a single human cell.

A visiting scholar at Stanford University and president of the Foresight Institute, Drexler recently returned from Switzerland, where he made two presentations about nanotechnology at the World Economic Forum, a meeting of several hundred business and political leaders, including 70 cabinet ministers and heads of state. As he spoke of nanotechnology producing a desktop computer that could surpass the *combined* computational power of every mainframe, mini and personal computer on the planet, there was a noticeable stir in the room.

For those who believe it's time for mankind to leave the cradle, the most exciting promise of nanotechnology will be to build interstellar ships and robotic space voyagers.

"Nanotechnology will enable the construction of just about anything you could have imagined before, but out of better materials and to more precise tolerances," Drexler says. "So any feasible scheme for interstellar flight can be implemented in a better form with nanotechnology."

Drexler refers to the atom-by-atom precision of assembling matter as "molecular manufacturing." And he believes the exactness of such an approach would allow creation of materials for laser-pushed sails that would be far more efficient than current technologies allow.

What would power the laser beam? "With molecular manufacturing making solar collectors in space as inexpensive as crabgrass on Earth," he says, "solar energy by the terawatt [trillion watts] will cost very little."

Drexler would have his laser-driven lightsails disassembled in flight and then remanufactured, first into a "cruise-phase" vehicle and then into a "deceleration-phase" vehicle.

Once the bacterium-sized assembler robots arrived at their destination, they could establish molecular manufacturing operations in the atmosphere of a new planet, using the local solar power for energy, and common elements such as carbon, hydrogen and nitrogen for building materials. At the top of the robotic 'Things To Do' list would be construction of an antenna to receive further instructions from Earth.

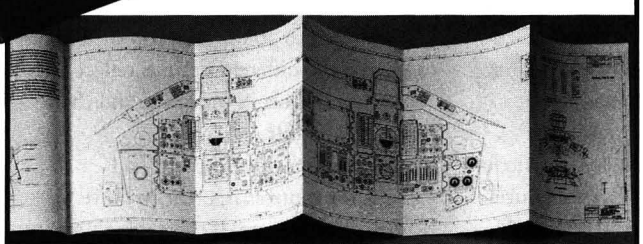
Drexler is also looking at the problem

LIMITED COLLECTOR'S EDITION!

The Space Transportation Systems Reference



"THE ULTIMATE FOR THE ASTRONUT!"
The Toronto Globe and Mail

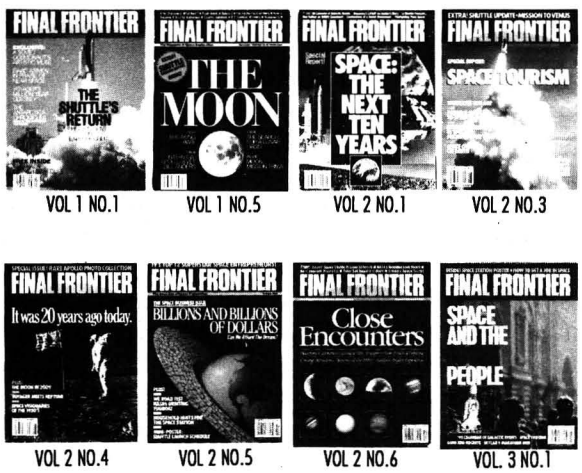


For a limited time, you too can have the book that's owned by Apollo, Shuttle and Mir Astronauts, famous people and thousands in 18 countries. This blue hardcover (with embossed shuttle in white and gold) contains 285 pages with over 150 photos and eight orbiter control gatefolds. Easy to read, you see all shuttle systems in PLAIN ENGLISH! In orbit or in testing, this superb shuttle source belongs in your library. Space educators love it! A special collector's edition, only a limited number of signed copies exist. Call now and reserve your passport to orbit.

$39.95 INCLUDES SHIPPING AND HANDLING

CREDIT CARD ORDERS CALL 1-800-24-LUNAR

OR SEND CHECK/M.O. TO: FINAL FRONTIER/APOGEE,
2400 FOSHAY TOWER, MINNEAPOLIS MN 55402



THE BEST OF FINAL FRONTIER

BACK ISSUES

Hurry! Limited Quantities. For back issues write to us at:
Final Frontier, 2400 Foshay Tower, Minneapolis, MN 55402.
Please enclose $5.00 for each issue plus $2.50 postage and handling.
To order by phone with your credit card call: TOLL FREE 1(800)24-LUNAR

of radiation shielding for starships. "At relativistic speed, the interstellar medium starts to look like a particle beam coming at you," he says. "And dust grains start to look like something much worse than high-explosive pellets." The solution, he thinks, has to do with ionizing the oncoming particles and deflecting them electrostatically. That may work, given the small size—one gram or so—of his spacecraft.

Drexler is looking at questions of that magnitude as he writes a more technical follow-up to *Engines of Creation,* in which he will examine the engineering foundations of nanotechnology, molecular machinery and molecular manufacturing.

"And that's a lot of work," he says, in understatement. —*Grant Fjermedal*

Pioneers

"What's so hard about going to Mars?" A team of scientists at the Lawrence Livermore National Laboratory in California, headed by the brilliant and controversial Lowell Wood, thinks it has the answer: "Nothing."

Wood, a longtime critic of NASA and a key figure in the SDI anti-missile program, threw Livermore's hat in the ring of Moon/Mars planning last year with a cheaper, quicker alternative to the space agency's plans that he calls "The Great Exploration." Among those who sat up and listened were Vice President Dan Quayle and the National Space Council.

Based on what the team claims is "off-the-shelf technology," the proposal starts with a space station launched into Earth orbit by an expendable rocket as early as 1992. The station would be constructed of inflatable modules with outer shells made of Kevlar-impregnated materials.

Two years later, a lunar base—also made of Kevlar inflatables—would follow. On the Moon, workers would live "spartan lifestyles," fortifying themselves on C-rations while converting lunar soil to fuel for the Mars journey. By 1996, a 64-ton inflatable Mars expedition vehicle would be sent into low-Earth orbit, inflated, checked out and outfitted for its voyage.

The Mars crew—made up of "hero types," not "junketeers"— would travel in no-frills style on their three-year round-trip. The total cost, according to the Livermore team, would be $40 billion, or about one-tenth the (very) rough estimates for NASA's program. The Mars landing would take place within 10 years, compared to NASA's 30.

Wood is no stranger to controversy, and the Livermore vision is hotly contended. One NASA official calls the plan "a sales mode"—a jazzy, upbeat sketch of what *might* be done, *if* everything fell into place, all systems worked at top efficiency, and luck ran high for the program from start to finish.

Wood, who contends that Mars-bound crews can survive long-term weightlessness and withstand the perils of interplanetary radiation, has made some scientists uneasy with his cavalier attitude about safety and his reliance on current technology. In March, the National Research Council criticized the plan, saying that it "underestimates the many engineering and operational challenges involved." The Council even pointed out that some of the Livermore ideas, like the



THE NASA ODYSSEY

America's Greatest Space Achievements

Witness America's greatest space achievements, including the X-15, Mercury, Gemini, Apollo, Skylab. Space Shuttle, and America's future -- the Space Station

All of the phenomenal achievements of NASA's rich history are brought together in these four captivating films:

- NASA ... the 25th Year
- Space Station ... the Next Logical Step
- Man in Space
- Launch Vehicles Soundclip

"If you only own one space video – this is it!"

"A definite must for your video library!"

Order your copy today!

Starbound Enterprises
5456 East Descanso Circle, Colorado Springs, CO 80918

☐ Send me, under your unconditional guarantee, **"The NASA Odyssey"** video. Payment of $19.95 plus $1.50 for shipping is enclosed. (Canada and Mexico $2.50 or $3.50 Airmail. Overseas $3.00 or $6.50 Airmail, Colorado and Florida residents add sales tax.

☐ Charge to my credit card: ☐ VISA ☐ Mastercard
Card No. _____ Exp. Date _____
Signature: _____

☐ Send brochure describing other STARBOUND products.

Please specify ☐ VHS ☐ Beta ☐ PAL-VHS ($29.95) (European Format)

Ship to:

Name (print) _____

Address _____

City State Zip

FF

Full Color, 90 Minutes ONLY $19.95

use of inflatables, are not new.

The cost figures and schedule also have raised eyebrows. But in presentations to NASA and the National Space Council, Wood and his colleagues have repeatedly emphasized what may be the most radical element of their plan: the willingness to move quickly and take risks, which, they claim, is the "American standard" approach to exploration.

Can Kevlar and C-rations cut the costs and beat the clock? Or is NASA's more conservative approach also more realistic? With the White House calling for several more years of study before a Mars mission scenario is fleshed out in detail, we still have time to find out. □

—Ray Spangenburg/Diane Moser

Grant Fjermedal is the author of The Tomorrow Makers, *which was named to the American Library Association's annual list of 10 Notable Books of Nonfiction. T.A. Heppenheimer's books include* Toward Distant Suns *and* Colonies In Space. *Eugene F. Mallove is chief science writer at the Massachusetts Institute of Technology's News Offices, and author of* The Starflight Handbook: A Pioneer's Guide to Interstellar Travel. *Tony Reichhardt is the editor of* Final Frontier. *Ray Spangenburg and Diane Moser are freelance writers in Carmichael, California and authors of a four-book series for Facts On File called* Space Exploration.

The Wrong Stuff

continued from page 23

ready for astronaut training and that women in general were suitable candidates: "It is our opinion that Miss Jerrie Cobb not only possesses no significant liabilities, but also possesses several exceptional, if not unique, qualities and capabilities for serving on special missions in astronautics...A ready acceptance of direction or a ready assumption of responsibility, as circumstances dictate. An exceptional ability to remain passive and relaxed when action is unavailable or unwise. An unusually smooth integration of psychophysiological function, a stable ego and a strong healthy motivation."

Meanwhile Cobb, along with Jackie Cochran, was combing the lists of American women aviators for more potential test candidates. Because there was no official funding — NASA's encouragement remained informal throughout — Cochran underwrote much of the cost. In the summer of 1961, under a strict secrecy order, 25 women pilots who had climbed to the top of the aviation heap were given the call to participate in the project. Twelve eventually passed the series of 75 exhaustive physical, laboratory, x-ray, psychological and other tests — a time-consuming ordeal that kept them away from home and cost many their civilian jobs (see page 22).

By May 1962, Cobb was reporting to Pensacola Naval Air Station for the third and final battery of tests. Two days of still more medical exams were followed by tests in a high-altitude pressure suit, boot camp-style routines to measure physical agility and strength, airborne electroencephalograms to check her brain waves under high g-forces, water survival training in the infamous Dilbert Dunker and a series of coordination tests in a rotating room.

Once again Cobb made the grade. She boarded a plane for Tulsa and a NASA

NASA
BOLDLY GO WHERE NO VIDEO HAS GONE!
PLANET AND UNIVERSE - William Shatner takes you on a two-hour guided tour of Space: THE FINAL FRONTIER
APOLLO - Apollo VIII, XI, XV, and XVII (2 HRS)
GEMINI - Gemini IV, VI, VII, VIII and XII (2 HRS)
MERCURY/ THE EARLY DAYS-Take a walk through history (2 HRS)
SPACE SHUTTLE - STS I thru VIII (2 HRS)
CALL TOLL-FREE 1(800) 437-0800
SPECIAL!
BUY THREE, GET THE FOURTH FREE!
ONLY$29.95 EACH!
Nolly Productions
5145 S. LEWISTON WAY
AURORA, CO 80015

conference on the peaceful uses of space. To her right at the banquet table that night sat NASA Administrator James Webb, who used the occasion to announce her appointment as a consultant to NASA.

Two other women who survived the first cut at the Lovelace Clinic came to stay with Jerrie Cobb as they underwent the phase-two psychological assessments in Oklahoma. Rhae Hurrle Allison and Wally Funk both whipped the tests, Funk setting a record in the isolation tank with a $10^1/_2$ - hour stay. The women were all set to begin phase three in Pensacola, Cobb later wrote, and were ready to join her as the nucleus of a woman astronaut corps. Then one day Cobb got a call. It was Lovelace, and the news was bad: The Navy had cancelled any further tests.

They tried after that, Jerrie Cobb and the other women, to revive the program.

Under strict secrecy, 25 women pilots who had climbed to the top of the aviation heap were given the call to participate.

They beat the drums in the media, on the lecture circuit and even up on Capitol Hill. In July Cobb and another of the test subjects, Janey Hart, testified at an open hearing of a special subcommittee of the Committee on Science and Astronautics of the House of Representatives.

Jackie Cochran testified too, but her message was not what some of the women test subjects wanted to hear.

"I do not believe there has been any intentional or actual discrimination against women in the astronaut program to date," Cochran stated. "The manned space flights are extremely expensive and also urgent in the national interest, and therefore in selecting astronauts it was natural and proper to sift them from the group of male pilots who had already proven by aircraft testing and high-speed precision flying that they were experienced, competent and qualified to meet possible emergencies in

SPACE PENS COME IN ALL SHAPES AND SIZES
The Perfect Gift Giving Idea!

The Impulse

Available in luminescent lacquers of Blue Sapphire, Deep Ruby, or Black Onyx, contemporary Black Chrome and elegant Sculptured Gold.



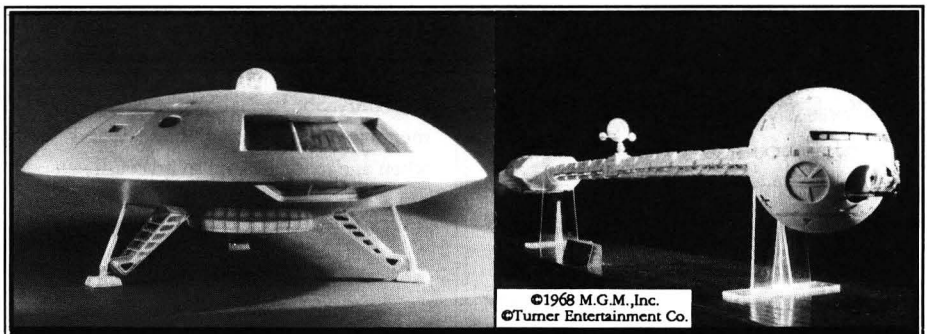
The Bullet

Available in modern Black Chrome, Chrome and Black Matte Finishes. Small enough for your pocket yet opens to a full sized writing instrument.

Pressurized to write at any angle—Even upside down and under water.
The only pen accepted for use by NASA on manned space flights.

call 1-800-333-0580 or visit your local dealer.

fisher PEN COMPANY



LUNAR MODELS PRESENTS
LIMITED EDITION SPACESHIP SERIES

Jupiter -2 from Lost in Space. This 1/35 scale, 16" diameter assembly kit is faithful in every detail to the classic from the 60's!

Discovery from 2001. 30" Long, 1/211 scale highly detailed hard plastic. Limited release.

These are just two of over 60 sci fi ships and model figure kits available.

$54.95 plus $3.00 S&H.

$89.95 plus $3.00 S&H

THE FOLLOWING WILL SOON BE AVAILABLE:

- Voyager
- Viking
- Hubble Telescope
- Lunar Rover
- Pioneer

For Catalog Send $3.00 and SASE to:

LUNAR MODELS

Dept. S. 5120 Grisham,
Rowlett, TX 75088.

OR CALL 1-800-662-4984.

MOST CREDIT CARDS TAKEN. ALLOW 6-8 WEEKS DELIVERY. ***DEALER INQUIRES WELCOME!***

SPACE STATION U.S.A. PRESENTS

A WILD RIDE BEYOND GRAVITY

GODSPEED STS-31 CREW, AND HUBBLE



GYRONA

first in multi-axis technology

You click in the foot bar, release the ring holder, and flip back your head— Whoosh!

Just that slight movement sends you effortlessly cartwheeling backward. Now you steer into a horizontal hang-gliding position and arch your back. This maneuver sends you spinning sideways in perfect figure eights. Now snap your arms like a 10-meter platform diver and glide into a perfect triple twisting side layout.

The fun is just beginning. Like a skydiver in free-fall, you soar and somersault, tumble and turn. Gravity falls away and you seem to enter the exhilarating realm of weightlessness. Like an astronaut, you move effortlessly through 360° of space.

FOR MORE INFORMATION CALL THE GYRO HOT LINE

1-800-421-GYRO

GYRONA

a new environment," Cochran said.

Cochran also noted that women had babies, and babies meant time away from work — too much time, she maintained, when the pace of technological change was moving so quickly.

"Because very few individuals will be used as astronauts in the near future and there is no shortage of well-trained and long-experienced male pilots to serve as astronauts, it follows that present use of women, as such, in this connection cannot be based on present need."

For those whom Cobb had named the FLATs — the Fellow Lady Astronaut Trainees — the space race had ended.

Twenty-eight years have not resolved all the disappointment and bitterness over those events, nor has it made it easier to fix the blame on any one person or agency. Some theorize that NASA Administrator James Webb was responsible, noting that Jerrie Cobb eventually gave up her position as a never-consulted NASA consultant in disgust, to pursue a career flying medicine and supplies into the Amazon jungle. She's still working there today, and doesn't like talking about the events of three decades ago.

Others point to the influential Cochran, who had the ear of soon-to-be president Lyndon Johnson and her own appointment to NASA. She had a lifetime of achievements in a man's world, they say, and when age made it time to gracefully step aside, she just couldn't give a hand up to another woman. Cochran died in 1980.

"I don't know if Cochran hurt or not, but she didn't help," says former participant Gene Nora Jessen, now international president of The 99s (the women pilots organization) and an aviation insurance specialist in Boise, Idaho. "Some think it was a dirty thing to do and others say,

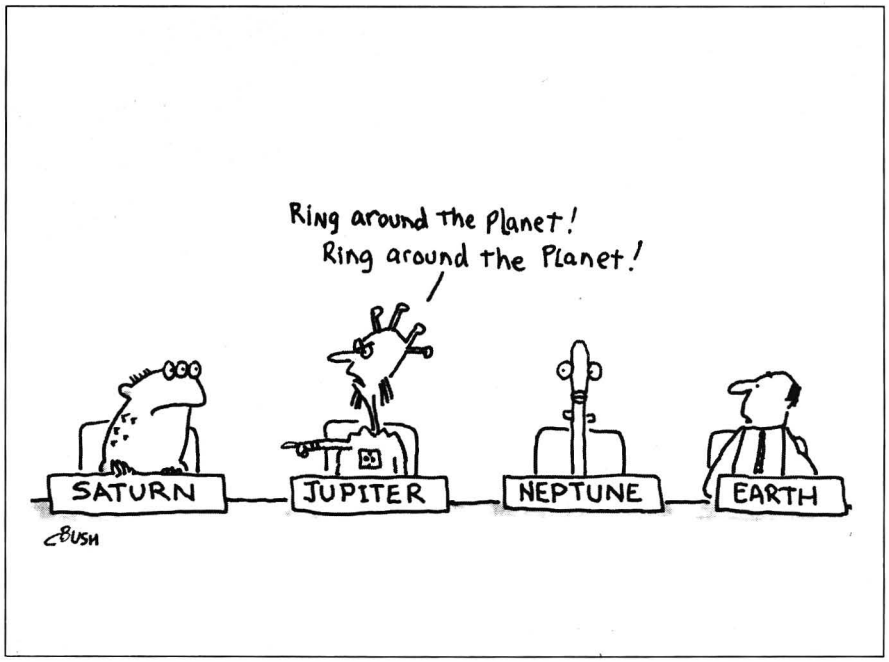
---

Just why they never made it can be debated. But one thing that surely helped to keep those women out of orbit was a society that was not yet ready to envision them there.

---

well, maybe she was being sincere. I don't believe she hammered in the last nail. There was bitterness at Jackie Cochran's response. But I got an impression...that it was pretty much a foregone conclusion that the Mercury astronauts had thrown their weight around and seen to it that there were no women in the program."

Whether they did or not, the Mercury



Seven certainly developed a camaraderie that was to serve them well in a political sense. The women trainees may have hurt their chances by failing to tighten ranks themselves. They were tested one at a time, and only a few ever met. Perhaps the women could have ultimately wielded more clout if they had turned a self-test exercise for loners into a group achievement.

Others believe the problems went deeper. Once an exclusive all-male bastion had been erected in space, they say, the door was soldered shut to the idea of a woman in the left-hand seat. "In the late 1960s NASA finally said to me, 'OK, Wally, you can apply. We would like to have women,'" recalls Wally Funk, still a professional pilot and instructor in Prado, New Mexico. "I did apply, and they came back and said, 'Well, you need an engineering degree and we'll give you nine months to get it.' There was no way possible for anyone, I don't care how smart you are, to get an engineering degree in nine months...It was clearly a good-old-boy network at that point."

A year after Cobb and the others ended their would-be astronaut careers in disappointment, a woman finally did get to fly in space. But she wasn't American, and she wasn't a pilot. Valentina Tereshkova, a cotton-mill worker and amateur parachutist, won the public-relations victory of launching the first woman into orbit for the Soviet Union. The victory was illusory, however: The Soviets took 19 years to send another woman into space, and have yet to fly a third.

As for the Americans, when the door was finally opened to women astronauts in 1978, it opened to stay. But not until this year did a woman earn the chance that was denied Cobb, Funk and the rest of their group a generation earlier. Eileen Collins—a 33-year-old Air Force Major selected in January as NASA's first female shuttle *pilot*—will, when her long-awaited launch day comes, at last get to ride in the front seat. □

Lillian Kozloski is a museum specialist at the National Air and Space Museum in Washington. Maura Mackowski is a freelance writer in St. Louis. Her article on Moon bases in the June 1988 Final Frontier *won first place in last year's Aviation/Space Writers Association competition.*

SCALE THE MARTIAN MOUNTAINS!

FLY THROUGH THE CITY OF THE ANGELS!

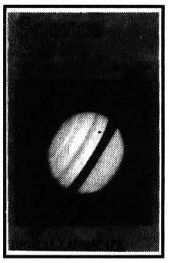
HAVE A CLOSE ENCOUNTER WITH MIRANDA! (The moon of Uranus, that is.)

IN THIS NEWLY RELEASED VIDEO:

DIGITAL LANDSCAPE: **...A VIEW FROM SPACE.**

Created at NASA's famous Jet Propulsion Laboratory, the sequences in *Digital Landscape* are stunning examples of the state of the art in remote imagery, image enhancement, and computer graphics animation, including:

* **Earth: The Movie**
* **Mars: The Movie**
* **LA: The Movie**
* **Miranda: - an exploration of the most mysterious moon of Uranus.**
* **Bonus Video: *Mission to Mars*. From the NASA planning office, a 3D animated simulation of the Mars rover mission.**



The sequences in ***Digital Landscape*** were produced from actual remote photographs from Landsat satellites and the Viking and Voyager spacecrafts. The photo images were specially enhanced, transformed into a 3D computer database, and used to create these beautiful simulated journeys. This high quality $ 19.95 (+s/h) video tape was recently evaluated and selected for sale in the Smithsonian Museum Shops.

New! History of: **"Man in Space"** Video Series

A premium quality compilation of the best NASA manned spaceflight films.

# 1	**Space Station: The Next Step Outward** (90 mins.)	**$ 21.95**
# 2	**Possible Futures in Space** (~30 mins.)	**$ 19.95**
# 3	**Research Project: X-15** (~30 mins.)	**$ 19.95**
# 4	**Project Mercury: The First Step** (~60 mins.)	**$ 21.95**
# 5	**Legacy of Gemini** (~30 mins.)	**$ 19.95**
# 6	**Time of Apollo** (~30 mins.)	**$ 19.95**
# 7	**Skylab: "Four Rooms, Earth View"** (~30 mins.)	**$ 19.95**
# 8	**"Houston, We've Got a Problem" (Apollo 13)**	**$ 19.95**
# 9	**"Challenger" Accident Investigation** (~30 mins.)	**$ 19.95**
#10	**Space Shuttle: "Getting There"** (~90 mins.)	**$ 25.95**

Complete Set of **"Man in Space"** Videos on five cassettes:
$ 159.95

Shipping and Handling Charges:
1 Tape - $3, 2 tapes $5, add $1 for each add'l. tape.

Send Check or Money Order to:

Video Publishing Group, Inc.
5055 NW 159th Street
Miami, Florida 33014
(305)-621-7283 - FAX 621-2815

Purchase Orders Accepted from Schools and Fortune 500 Companies.

VPG Video Publishing Group **Video Publications**

Please Allow 3-5 weeks for delivery.

Global Currents

Japan's Hotel In Space

Where a long weekend will be truly out of this world

By Alan Ladwig

"I firmly believe that we are going to have Hiltons in outer space, perhaps even soon enough for me to officiate at the formal opening of the first."

—Barron Hilton, 1967

For the vast majority who told *Final Frontier* that they're ready to make reservations for a trip into orbit (January/February1990), take heart—you'll have a place to stay! If Japan's mega-construction company Shimizu delivers on its plans, you could be checking into a suite in the stars as early as the year 2020.

While it's still too early to tell if the bath towels and ashtrays will say "Hilton" or "Holiday Inn," officials from Shimizu's Space Projects Office are actively promoting their vision of the first orbiting space hotel. In a paper presented at last year's International Astronautical Federation (IAF) Congress in Spain, Japan's oldest and largest (1988 revenues of $9 billion) construction company announced that they intend to be the contractor of choice for commercial space operations.

Just prior to the 1987 release of Japan's government-sponsored long-term space plan, Shimizu established a Space Projects Office. The government plan predicted increased interest and investments in space activities by the Japanese private sector, and Shimizu decided to become a major player in the coming boom. The hotel is only one of the company's several space-related priorities, which also include developing launch facilities, space stations and platforms, lunar bases and space information services.

A glossy, full-color Shimizu brochure depicts the hotel complex as a ring of guest modules connected to a central, 787-foot elevator shaft, which runs through an inverted pyramid containing public space. At the parking-garage level, an aerospace plane is mated to a brace of space-station-like modules. Space pods hover nearby, presumably containing guests engaged in the many advertised "leisure activities."

Shimizu's officials estimate that 7,500 tons of material (or some 300 space shuttle loads) must be hauled from Earth to build the $28 billion facility. This will be phase one of a "space resort network" that will eventually include a lunar hotel. Both are key elements in Shimizu's plan for cornering the space tourism market predicted for the 21st century.

The brochure includes a six-day itinerary for up to 64 hotel guests. Only two and a half days will actually be spent at the orbiting resort, due to physical concerns, and "to allow as many people as possible to have this experience." And what will the experience be?

continued on page 58



SHIMIZU

Hotel rooms will feature all the earthly amenities—and a great view.

FINALLY A CONTEST WHERE EVERYONE'S A WINNER! INTRODUCING

FINAL FRONTIER'S "SHOOT FOR THE MOON!" SUBSCRIPTION CONTEST



WIN A FREE SHUTTLE LAUNCH TOUR!

Imagine yourself ringside at a spectacular space shuttle launch, the special guest of FINAL FRONTIER magazine. An expense-paid adventure for two to Florida's exotic Spacecoast ... with an insider's view of Kennedy Space Center... to witness first-hand the breathtaking launch of a space shuttle as it roars off the pad into outer space!

Enter the "Shoot for the Moon" Subscription Contest This special Shuttle Launch Tour is the Grand Prize that will be awarded to one lucky winner in FINAL FRONTIER's "Shoot for the Moon" Sales Incentive Contest. And there are plenty of other prizes. Because this is one contest where everyone who enters "wins." Here's how...

To enter, just recruit one person to subscribe to FINAL FRONTIER magazine and you'll win a FREE one-year subscription for yourself! If you're already a subscriber, we'll extend your subscription for another full year — absolutely FREE! Either way, it's a $14.95 value!

Go for volume sales and really win big! For each subscriber you recruit, FINAL FRONTIER will reward your efforts with special prizes along the way (see prize box for details). The entrant that brings in the most number of new paid subscriptions wins the Shuttle Launch Tour!

Demonstrate your commitment to the cause This is also an opportunity for those who feel strongly about FINAL FRONTIER's mission: to build public support for space exploration. To create that kind of support means we must dramatically increase our already rapidly expanding circulation. That's why we're inviting you, our loyal readers, to help us reach our important goal — and be rewarded for your efforts at the same time. Surely there's a friend or associate who could — who should — be a subscriber to FINAL FRONTIER. How about a gift subscription for a relative or local library? The possibilities are endless — and all worth pursuing!

Act now —This is a limited time offer! Subscription entries must be postmarked by July 15, 1990, with the winners announced in September. Start your subscription drive today and help FINAL FRONTIER "Shoot for the Moon" with its national circulation.

"Shoot for the Moon" PRIZES

PLACE	CONTEST PRIZES
1st	• Airfare and hotel for two to Florida's Spacecoast. • Tour of Kennedy Space Center. • Pass to view a space shuttle launch from a special viewing area.
2nd	• A complete Collector's Edition set of all FINAL FRONTIER issues published to date, bound in an attractive embossed binder. These include archive editions no longer available.
3rd	• The Shuttlescope by Jason, featuring a 600mm focal length and finderscope. Great for your home or office!

AWARD LEVEL (SUBSCRIPTIONS)	PRIZE
1-4	FREE 1 yr. subscription or extension.
5-9	FREE 5-yr. subscription plus a signed "Certificate of Appreciation"
10+	FREE 10-yr. subscription plus an appointment to the FINAL FRONTIER advisory board.

"Shoot For The Moon" Contest Rules:

1. To enter FINAL FRONTIER's "Shoot For The Moon" Sales Incentive Contest, complete and mail the form at right (or a photocopy of the form), and a check or money order or credit card (Amex, MC, VISA) for $14.95 for each subscription. Send entries to: "Shoot for the Moon", Final Frontier Publishing, 2400 Foshay Tower, Minneapolis, MN 55402. Be sure that your name and address and all other names and addresses are listed completely and correctly. NO cash will be accepted. Final Frontier Publishing assumes no responsibility for lost or mis-directed mail.
2. To be eligible, all orders must be postmarked by July 15, 1990, only U.S. orders will be accepted. You do not have to be a current subscriber to enter. Subscriptions need not be sent all at once; FF will tabulate orders over the contest period and credit them to your name. Only paid orders count as entries. Only valid payments will be counted towards prizes.
3. In the case of a tie, the winner will be determined by a random drawing. All decisions of the judges are final. Winners will be notified by telephone and/or mail.
4. Taxes on prizes are the sole responsibility of the winners. No substitutions will be made for any prize offered. All prizes will be awarded.
5. Contest open to all residents of U.S. Employees of Final Frontier Publishing and BWN, Inc., their families and stockholders are ineligible. Contest subject to Federal, State, and local laws and regulations, and is void where prohibited by law.
6. The Grand prize availability will be awarded based on the NASA schedule of launch dates. Once travel arrangements have been booked no changes will be made.
7. Decisions of the judges are final.

Mail to:
FINAL FRONTIER "SHOOT FOR THE MOON"
2400 Foshay Tower Minneapolis, MN 55402

Please print all information

Your name _____

Address _____

City _____ State _____ Zip _____

Daytime telephone ( ) _____

Are you currently a Final Frontier Subscriber ❑ YES ❑ NO

Enter a 1 year subscription (6 issues) for:

Name _____

Address _____

City _____ State _____ Zip _____

Enclosed is a check, money order or credit card information for each subscription. NO CASH will be accepted.

Credit Card: ❑ MC ❑ VISA ❑ AMEX

Card # _____ Expiration Date _____

Signature _____

QSWF90

INVEST IN SPACE EXPLORATION TECHNOLOGY

APPLIED RESEARCH CORPORATION

Is participating with NASA on projects such as the Space Shuttle program and Hubble Space Telescope.

CONTACT

Richard A. Crosby

1-800-878-7801
Member
NASD-SIPC

Century Capital Securities Incorporated

7800 East Union Ave Denver, Colorado 80237

Century Capital Securities Incorporated makes a principal market in applied Research securities, and it or its associated persons may own stock and warrants of the company. Recent common stock price was $1.25 bid, $1.50 ask (Philadelphia stock Exchange). This is not a solicitation or offer to buy or sell any security. Additional information is available upon request.

Global Currents

continued from page 56

Day One: After checking in at the International Space Port located in the Pacific Ocean, guests will attend an orientation session and a manager's welcome party.

Day Two: Guests will be given "simple instructions and informative lectures" on safety procedures and the effects of weightlessness.

Days Three and Four: A one-hour rocket ride delivers guests to the hotel, where they'll unpack in their artificial gravity modules. The 100 hotel rooms are mounted on a wheel-shaped frame 460 feet in diameter and rotating at three revolutions per minute. The hotel rooms will be like those on Earth, complete with sofa bed, toilet, shower, window, desk and a liquid-screen television.

Guests will partake in leisure activities, including space walks, sports, theater, experiments, astronomical observations and Moon forays. There are even plans to perform space weddings. The Shimizu brochure doesn't mention a bar, but as hotel executive Barron Hilton told a 1967 meeting of the American Astronautical Society, "If you think we're not going to have a cocktail lounge you don't know Hilton—or travelers."

Days Five and Six: Guests pile into the aerospace plane for re-entry. Following a cursory medical scan at the space port, it's time for the galactic farewell party. Check-out time is 10 the next morning.

The Shimizu brochure doesn't list a ticket price, but a brief cost analysis in the paper presented at the IAF meeting seems to suggest that a hotel could break even by collecting $43,500 from 11,520 guests a year. That's a little higher than *Final Frontier*'s survey respondents said they would pay for a trip into space, but then again you have 30 years to start saving.

Shimizu's time schedules, risk assessments and cost estimates may turn out to be light-years off the mark. But in 1967 Barron Hilton was already saying that it was time "to get busy with our orbiters before somebody beats us to it." It looks like a Japanese construction company intends to make that prophecy come true. □

Onboard Freedom

continued from page 41

In the end, astronauts will probably enjoy a pretty healthy choice of hot meals and sandwiches, as well as a week's worth of relatively fresh fruits and vegetables when the resupply shuttle arrives. Sushi, however, is probably out.

All meals will be prepared in two (possibly three) microwave/convection ovens. Dishes and silverware will be washed in a zero-g washing machine. Food will be served in bags so your peas don't mix with someone's free-floating corn in the weightless zone between dinner partners. Everything will be served on trays that can be strapped to your legs or attached to the wardroom table.

Also in the galley will be a complete refrigerator and freezer that pull down out of the ceiling, pantries of supplies provisioned from one of the pressurized modules delivered by the shuttle and a clothes washer and dryer — which will probably be stowed in the ceiling as well. Home sweet home.

Though it will hardly be a city in orbit even by the year 2001, Freedom *will* be a busy place. After all, one of the main arguments for building an orbiting base is to provide a place where humans can perform materials processing and microgravity experimentation, as well as life-sciences studies, astronomy and Earth observation. In fact, critics of the station say NASA is trying to do *too much* on one station. How can you perform sensitive materials processing or microgravity experiments while shuttles are docking, telescopes are being mounted or an astronaut is plunging away on a rowing machine 100 feet away?

NASA's basic answer is twofold: You can't please everybody, and you have to start somewhere. According to Frank Martin of NASA's Office of Aeronautics, Exploration and Technology, materials science experiments in space will first have to be run by humans before we learn to automate them. In the meantime, he says, "You need to...isolate the experiments."

The European Space Agency plans to skirt this problem by building a Man-Tended Free Flyer. The MTFF (NASA's penchant for acronyms has apparently

bridged the Atlantic) will be among the last ESA space-station facilities to be built. It will orbit Earth independent of the station, monitored and visited every few weeks or months by the European scientists onboard Freedom. This ensures that the experiments on the MTFF will remain undisturbed until they're ready to be checked.

Otherwise most science will be performed within the station's lab modules. As on the shuttle, the experiments will be placed in drawers housed in metal racks that can withstand the stress of launch. These experiments will be prepared in advance on the ground, placed in logistics modules — the station's equivalent of storage closets — and stowed in the shuttle cargo bay. When the shuttle docks with the station, the station's Mobile Servicing System (operated tele-robotically from a windowed "cupola" that provides a clear view of the cargo) will haul the carrier out and affix it to the resource node that connects the habitation module with the European laboratory module.

The modular nature of the racks will allow them to be locked into the floor, ceiling and walls of the laboratory. Power, air, water, various gases — whatever is necessary — will be run directly into them from behind. If anything goes wrong (say, for example, one of those nasty renegade water droplets short-circuits power to a particular drawer), an ingenious design that anchors one end of the rack to a pivot where floors and walls meet will allow an astronaut to pull it down like a Murphy bed out of a wall. This way the entire rear assembly is exposed and accessible for repair — just float up and over, and go at it. When the snafu is solved, the rack is pushed back and work continues as usual.

The U.S. and ESA lab modules will be roughly the same size as the habitation module, and the U.S. lab will have a second bathroom for the use of all crew members. The Japanese Experiment Module (JEM) will be a touch shorter than the other labs, but will be outfitted with an exposed platform for special "outdoor experiments." Another JEM feature will be a handy resource node, which will act as a kind of space-age attic atop the module.

Each laboratory will be equipped with an impressive array of futuristic technology — computers, diagnostic equipment and

Youngst☆r Space Academy

ASTRONAUT TRAINING PROGRAM

For Grades 4 to 12

- Rocketry
- Flight Training
- Space Science
- Shuttle Training

The program also includes hundreds of experiments, astronaut physical fitness training and **actual flight time.**

The challenge still remains...

For additional information, please write or call:
Youngstar Space Academy
P.O. Box 9425
Silver Spring, Maryland 20906
(301) 598-9334
collect calls accecpted.

See the final frontier in person and save up to 60%!



Authorized Meade Dealer

$1200 $699

Save on famous name telescopes – from Meade, Celestron, Questar, TeleVue, Edmund . . . and more.

The Meade 2045D, left, is one of the world's most convenient telescopes. Exceptionally portable, this very complete astronomical observatory weighs only 16 lbs., yet packs 4" aperture 40" focal length optics into a tube only 10" long. Complete with tabletop tripod legs; slow motion controls; a built-in motor drive (powered by penlight batteries) that lets you use your scope anywhere in the world; a finderscope; a 40x eyepiece (optional eyepieces provide additional powers from 25x to 250x); a lifetime warranty from Meade Instruments, the leading U.S. telescope manufacturer; and more. A few inexpensive accessories even turn it into a terrestrial spotting scope or a 1000mm f/10 telephoto lens! The entire Universe is yours for the looking through this exceptional telescope – *and all at a savings of over 40%!*

Send a stamped self-addressed envelope today for our free catalog and discount price list 90F showing your savings of up to 60% on scores of telescopes, birding binoculars, and spotting scopes from every major manufacturer – at prices from $49 to $14,000!

astronomics 2401 Tee Circle, Suites 105/106 Norman, OK 73069 (800) 422-7876

10:00 to 5:30 CST, Monday thru Friday – Within Oklahoma, (405) 364-0858 – Our 11th year of saving you money on quality optics. MasterCard, Visa, American Express, Optima, Discover (Add 3% freight on credit card purchases.) US and Canadian sales only.

STARSPAWN MAGAZINE

STARSPAWN Magazine is dedicated to world peace through education. We seek the different view.
STARSPAWN is geared towards the adult comic book reader who is tired of children's literature formats and includes timely articles, poetry and artwork on science fact, science fiction, fantasy and sword and sorcery.
STARSPAWN contains exclusive interviews with people who are an active part of the science and science fiction universe. You'll also find out what's hot on the presses to what's hot on the video counter.
For advertising contact :
B.T. Warren, 423 Ave. C, Suite 203, Bayonne, New Jersey 07002.
For subscriptions contact:
C.B. Josephs, 1045 E. 59th Street, Brooklyn, New York 11234.

STARSPAWN™
THE RIGHT APPROACH
MAKES A DIFFERENCE

a nifty simplified tool box for mechanical repairs. Designers in Houston are even working on a modular software concept that will transform the lab's computer terminal into whatever piece of electronics you happen to need, the way a Nintendo cartridge transforms a television into different forms of video escape. Plug in one software package and you have an oscilloscope; another, a logics analyzer, and so forth.

Designers long ago gave up on the idea of creating a system on Freedom that would entirely and continually recycle all of the station's air. Instead, the shuttle will transport Freedom's atmosphere into space as liquid oxygen and nitrogen, where it will be transformed into something breathable.

Nevertheless, a lot of air *will* be used again and again — at least as much as within your average intra-ventilated modern office building. As closed systems go, the station is quite small, and there are bound to be odors — cooking odors, laboratory odors, people odors.

Scrubbers in the ventilation system will strip out bad gases and carbon dioxide, while charcoal filters will reduce odors and bacteria. To further help reduce the chance of offended olfactory bulbs, the system may also lightly scent the air. How about cherry blossoms in May and evergreens in December?

With only eight crew members and so much to accomplish, job flexibility will be crucial onboard Freedom. Almost everyone will be trained broadly enough to serve in almost any capacity. Nonetheless, the crew can be divided into three main categories: station scientists, payload scientists and station operators.

At any given time, six people will be working in the lab modules on experiments shipped from Earth. These investigations will differ widely, but the station scientists will be well schooled in what their counterparts on the ground want to accomplish.

On certain occasions there may be a need for a "payload scientist" whose focus is more narrow. On these rare "increments" — the space station term for a tour of duty — a specially trained astronaut will be onboard to deal almost

STS
THIRTY-FIVE
Shuttle Mission Club V

Final Frontier's Shuttle Mission Club V featuring top astronomers viewing galaxies and quasars from the bay of the space shuttle. Hurry supplies are limited.

You receive:
Mission highlights video
(including post mission conference)
Press kit
Orbital track map
Flight plan
Crew photo
Mission patch
Storage binder

A LONG TIME AGO
IN A GALAXY
FAR FAR AWAY...



sample shown is STS-32 not STS-35

Just fill out this coupon and return to:
FINAL FRONTIER SHUTTLE CLUB V
2400 Foshay Tower Minneapolis, MN 55402 FAX# (612)332-0034
OR CALL TOLL FREE *1(800)24-LUNAR* FOR FAST DELIVERY.
❒ **YES!** *Rush me my STS-35 Shuttle Club V for only $44.95+$3.00 S/H*

name (please print)
address
city state
phone

METHOD of PAYMENT
❒ Check/money order ❒ Visa ❒ M/C ❒ Am.Ex.
signature
credit card no. Exp. Date

For Canadian surface shipment add $5.00, overseas add $8.00 Allow at least 4 weeks after completion of mission.

SAVE YOUR COPIES OF FINAL FRONTIER

These custom-made titled cases and binders are ideal to protect your valuable copies from damage. They're designed to hold two years of issues. constructed with reinforced board and covered with durable leather-like material in blue, title is hot-stamped in gold, cases are V-notched for easy access. Binders have special spring mechanism to hold individual rods which easily snap in.



Cases:	**1-$7.95**	**3-$21.95**	**6-$39.95**
Binders:	**1-$9.95**	**3-$27.95**	**6-$52.95**

FINAL FRONTIER
Jesse Jones Industries, Dept. F-FR
499 East Erie Ave., Philadelphia, PA 19134
Enclosed is $_____ for_____ Cases;
_____Binders. Add $1 per case/binder for postage & handling. Outside USA $2.50 per case/binder (us funds only). PA residents add 6% sales tax.
print name_____
No P.O. Box Numbers Please
Address_____
City_____
State/Zip_____
CHARGE ORDERS (MINIMUM $15) : Am Ex, Visa, MC, DC accepted. Send card name,Expire date.
CALL TOLL FREE 7days, 24 hours
1(800) 972-5858
SATISFACTION GUARANTEED

exclusively with a certain complicated payload or experiment.

Meanwhile, two station operators will see to it that Freedom functions on a daily basis. They will operate equipment from the nodes and cupolas, oversee the unloading of supplies arriving from Earth and direct the robots that maintain the station and its external equipment. They also will control many of the instruments that will be monitoring Earth, the Sun and the rest of the cosmos from outside the modules — the station's so-called attached payloads. When robots can't do the job, these astronauts will float into the station's airlock, suit up and head out into space in their Mobile Maneuvering Units to do the dangerous work by hand.

What about the order of command on Freedom? Who has the final say? The arrangement won't be exactly military in nature — remember, this is a civilian operation. But there will be a station commander responsible for crew safety, the station's integrity, protocol and discipline. He or she also will settle arguments, appoint the day's designated chef and decide who pulls the orbital equivalents of KP and latrine duty.

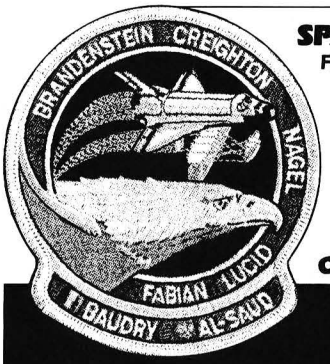
You might expect a station operator to be the commander, but a station scientist would be just as likely to earn the position, given the importance of the scientific experiments. Many of the conflicts onboard Freedom could involve a clash between different scientific disciplines, and a scientist might have the perspective needed to solve such disputes.

Whatever their duties, all crew members must learn to work in weightlessness. Push too hard off the floor and you could catapult yourself into the ceiling. There is also the trick of keeping your hands free to work rather than holding you in place. The station will be fitted with countless handholds, but you won't be very efficient on a delicate chore if you're constantly reaching out to grip one.

Designers, however, are considering a few solutions. Seat tracks, for example — although foot tracks would be a more accurate name. These are similar to the rails that anchor down airline seats. They'll run along the floor, and a special cleat on the shoes will allow astronauts to hook themselves in. Another design includes padded foot holds running along the bases of walls. The consequences of weightlessness are bound to pop up everywhere. What happens if someone shuts off the shower too tightly? The next person who tries it may end up turning circles instead of the faucet handle.

Despite the problems and the risks, life on Freedom will be a remarkable experience. Sure, people will get on one another's nerves and simple tasks will be difficult to perform. It won't always be fun, but it will always be exhilarating. Who among us will ever experience the thrill of working in a place where you can look out one window and watch an entire world with all of its mysteries and dramas spinning below, and then (while running some seemingly mundane errand) peer out another and find the rest of the Solar System at your feet? □

Chip Walter recently completed development of an eight-part series for PBS called Space Age *that will air in 1992. He's currently working on a screenplay for Warner Bros.*



SPACE SHUTTLE SERIES SPECIAL OFFER
FROM A SUPPLIER WHO PROVIDES PATCHES TO NASA

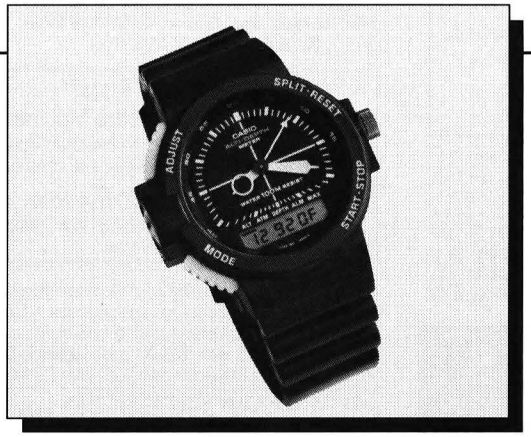
STS 51-G DISCOVERY: *Brandenstein, Baudry, June 17-24, 1985 Saudi, French Crew Members Deployed 3 Communication Satellites.*

ONLY **$2.77**

Authentic richly embroidered in brilliant color detail
4½ inch patch
Limited time offer/One per customer
Satisfaction Guaranteed

Hundreds of patches available.

Receive FREE our $3.00 NASA/Military Patch & Luggage Color Catalog with first time purchase. Send $2.77 plus $1.00 for shipping & handling. International orders add $2.00 shipping & handling. Check, money order, or VISA/MasterCard to:
Eagle Crest P.O. Box 6115 Dept. F1 Jacksonville, FL 32236



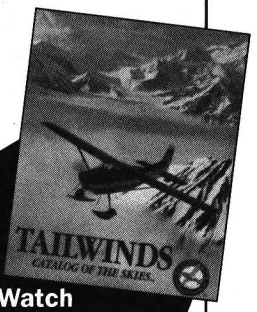
TIME FLIES

The World's First Altimeter Watch!

SALE $89.95
Plus $4.50 shipping & handling

If you're always looking for your altimeter, even when you are not flying, this watch is for you. By setting the known altitude or barometric pressure, a sensor is able to approximate the relative altitude by determining the relationship between altitude and atmospheric pressure. Our altimeter watch features:

- stainless steel casing with rubberized band
- a measuring range from 0-13,120 ft.
- 98 foot water resistant depthmeter
- 12/24 hour digital timekeeping
- 12 hour analog display
- countdown alarm
- altitude alarm
- stopwatch
- calendar



To Order Your Altimeter Watch Or Request Our Color Catalog
CALL TOLL-FREE
800-992-7737
or write to:
Tailwinds
1180 Holm Rd., Petaluma, CA 94954

CLASSIFIED ADS

RATES AND REQUIREMENTS

$55 minimum for 5 words. $1.75 each additional word. 10% discount if prepaid for 3 issues. (same ad); 15% discount prepaid for 6 issues. Box or blind ad,$10 additional. Payment must accompany order. Non-commissionable. Include name, address & phone number. Advertising accepted at sole discretion of publisher.

DISPLAY CLASSIFIEDS

$110 per column inch, one time; $95 per column inch, 3 times; $90 per column inch, 6 times. Column inch is 2 1/4i n. wide. Please design height in whole inches. Display ads can be designed for an additional charge.

DEADLINE & MAILING INSTRUCTIONS

Copy/mechanicals must be received 60 days prior to publication date (i.e. May 1 for July /Aug. issue) Mail copy or materials with payment to : FINAL FRONTIER MAGAZINE, Classified Dept., 2400 Foshay Tower, Minneapolis MN. 55402. For further information, call Stephen Martin at 612-332-3001.

SPACE COLLECTIBLES

SPACE SHUTTLE PROGRAM exciting NASA color prints collection. For catalog and sample send $1.50 to SPACE COLLECTION, Box 701-S, Cape Canaveral, FL 32920

OFFICIAL GLAVKOSMOS DESIGNS

Exclusive Soviet Official Pins/Patches & NASA 30 year collection. Closing out final inventory of many Limited Edition NASA pins. Send $2 for our complete international space pin & patch catalog (deductible from order) SpaceCom International, 22653 Pacific Coast Hwy #117 Malibu, Ca 90265

SKY ROCKS-Actual certified space tektite meteorites. Pieces of other worlds, comets, asteroids. $5.50. Geyer, 1501 Roosevelt Ave, F-1, Carteret, NJ 07008.

APOLLO 15 SOUVENIR CARD: Affixed to this limited edition, numbered, 4-color card is extremely rare graphite that landed on the moon during Apollo 15. $35. BYLINA, PO Box 25844, Colorado Springs, CO 80936

METEORITES !

Rare space collectibles. Irons. Stones. Stony-irons.Tektites. Space jewelry. books. metal detectors. Authenticity guaranteed. Catalog $2.
Bethany Trading Co.
P.O. Box 3726 F
New Haven. CT
06525
★CATCH A FALLING STAR!
(203)393-3395

FOR SALE - $50 pounds of payload opportunity on space shuttle mission, G.A.S. #650. Write offer to Geyer, 1501 Roosevelt Ave, F-1, Carteret, NJ 07008

AUTHENTIC SPACE ARTIFACTS from Cape Canaveral plus Apollo XI and STS-5 missions. Send $1.00 for description of items. Daugherty, RD2 Box 277, Acme, PA 15610.

COLLECTORS
PATCHES • TACS • DECALS • ETC
For Catalog Send $2.00 To:
Sky Patch Enterprises
P.O. Box 3339, Dept. F
Lompoc, CA 93438
Outside USA $3.00 US Currency

COMPUTERS & SOFTWARE

The unique Howington Orrery has arrived. A planetarium for PC compatibles. Observe planet orbits, flights of both Voyagers, and Halley's comet. You control time, speed and size of your own little universe. Send $29.95 (CA add $1.95 tax) to: LOGIX DEVELOPMENT CORP., 17149 Chatsworth #208, Granada Hills, CA 91344 (818) 360-8147

SCIENTIFIC SOFTWARE
FOR IBM, APPLE & COMMODORE
- **PUBLIC DOMAIN** — Astronomy, Earth Science, Geography, Chemistry, Math, Physics, Engineering, Statistics, Health, Electricity and more. FREE CATALOG - Specify IBM or Commodore. $3.99 per disk.
- **ASTROVIEW** — Planetarium and database. (Commodore 64/128 or Apple IIc/IIe with 64k/80 columns) $39.95
- **JOVIAN SYSTEM SIMULATOR** — A simulation of the Galilean Satellites of Jupiter. (IBM & compatibles) $24.95

For info write: Andromeda Software Inc.
P.O. Box 1361-F, Williamsville, NY 14231-1361

Hundreds of IBM PC Shareware and public domain programs. 2 disc sampler, $5 (shipping/handling). FREE catalog and coupon. SoftWareHouse, PO Box 5111, Phillipsburg, NJ 08865-5111

Satellite Pro™
Satellite Tracking for the Macintosh®
Maps • Ground Tracks • Views from Space
Tabular Data • Antenna Control • $99.95
MacTrak® Software
P.O. Box 1590 Port Orchard, WA 98366
(206) 871-1700

CELESTIAL COMPUTING: A Journal for Personal Computers and Celestial Mechanics. Computer applications in astronomy and astrodynamics. Sample issue $6.95 ($10 with IBM-PC disk). Science Software, 7370 South Jay Street, Littleton, CO 80123-4661

FREE ASTRONOMY SOFTWARE! 300+ programs and databases. From NASA, JPL, space industry and academic sources. FREE catalog. State computer type. Send SASE: PC-ASTRONOMY, 55 Hillside Road, Sparta, New Jersey 07871

BUSINESS OPPORTUNITIES

GET PAID for mailing letters! $200.00 daily. Write: PAASE-TN6, 161 Lincolnway, North Aurora, IL 60542

CLOTHING



SPACE & ASTRONOMY DESIGNS ON HEAVY-WEIGHT T-SHIRTS + SWEATS
CALL OR WRITE FOR FREE CATALOG
Caledonian Graphics,
Dept. F,
P.O. Box 875, Zephyrhills, Fl. 34283.
1-800-223-4607
CALEDONIAN GRAPHICS

ROCKETRY

ROCKETS! SPACESHIPS!
Out of production, hard to find: model rocketry, NASA publications, collectibles. Catalog $1.
ACME ROCKET COMPANY,
Box 28283-FF50, Tempe, AZ 85285

DOCTOR WERHNER VON BRAUN'S
CARGO ROCKET



KIT NO. SFDE 001
$56.95 includes P/H
VA Res. add 4.5% sales tax
A RESIN KIT: 1/480 SCALE
MODEL HEIGHT: 7 INCHES
D & E MINIATURES
835 Holly Hedge Ave. • Va Beach, VA 23452

BUILD YOUR OWN SOLID FUEL ROCKET MOTORS!



- UP TO 80 POUNDS THRUST USING SIMPLE
- LOCALLY AVAILABLE MATERIALS FOR JUST
- PENNIES APIECE!

Homemade motors go together quickly. Use homemade fertilizer/charcoal fuel. Models fly thousands of feet for as little as a SEVEN CENTS per flight! Speeds to MACH 1!

Write for our catalogue of books & plans, and we'll send you a working sample of a homemade electric rocket igniter AND teach you how to make your own homemade rocket motor castings, all using materials you'll find around your house.

SEND $2.00 TO:
Dept. F2, THE TELEFLITE CORPORATION, 11620 Kitching Street, Moreno Valley, CA 92387

VIDEO

SPACE VIDEOTAPES
Quality NASA produced videotapes on Apollo-Lunar, Mercury, Gemini, Challenger, and unmanned probes Mariner, Voyager, and Viking
Write for our FREE illustrated catalog .
SPECTRUM Video, Dept. F
PO Box 3698, Ontario, CA 91761

SPACE✳SCIENCE ✳AVIATION VIDEOTAPES
For a free illustrated catalog, Write to
SPACE FLIGHT PRODUCTIONS
38 BRAWELY AVE. TORONTO, ONTARIO
CANADA, M87 474. (416-252-9837).

SPACE FLOWN MEMORABILIA & VIDEOS
ACTUAL SPACE FLOWN Articles along with actual APOLLO
CM & LM Hardware & Apollo Tracking Charts!!
Over 40 1 Hr. Mission Videos containing over 60 MISSIONS. Examples: Apollos 10 & 11, 12 & 13, 14 & 15, 16 & 17; Plus all Shuttle Missions - - Only $19.95 each!!
Apollo / Shuttle Press Kits & Flight Plans available!!
STS Press Kits (info) $10.00 FLIGHT PLAN $20.00
AVD 767 St. Michaels Dr. Mitchellville, MD 20721

FREE SHUTTLE PIN

WITH YOUR 5 YEAR SUBSCRIPTION OR RENEWAL TO FINAL FRONTIER. SEE PAGE 57 FOR DETAILS.

BOOKS

BAFFLED by buying binoculars? Our booklet can help you make an informed purchase. Send $3.50 for "BINOCULARS-FF01" TechSource, PO Box 21992, Charleston, SC 29413-9998. Also available: "TELESCOPES-FF01".

FREE! World's first Hologram stamp (U.S.P.S.). Fantastic space shuttle theme, with trial of order "Space Capsules" weekly newsletter. 4 weeks $10. Clipping services available $50 monthly. Guyer, Cape Canaveral Florida 32920-1574.

Books, Software, Videos, Games & More

Space, Science, Technology, Environment, Quality, Productivity, Creativity & Innovation

Are you interested in a wide variety of subjects?

Send for free catalog to:

Our Planet Publications

P.O. Box 128, Yorkville, IL 60560

AUTHORS WANTED BY NEW YORK PUBLISHER

Leading subsidy book publisher seeks manuscripts of all types: fiction, non-fiction, poetry, scholarly and juvenile works, etc. New authors welcomed. Send for free, illustrated 40-page brochure H-120 Vantage Press, 516 W. 34 St., New York, N.Y. 10001

EDUCATION

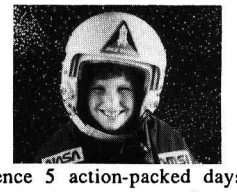
U.S. SPACE CAMP®

Register now for a week-long adventure into astronaut training and simulated Space Shuttle missions. Grades 4-6 for **U.S. SPACE CAMP** in Alabama and Florida. Grades 7-12 for **U.S. SPACE ACADEMY**. Write **U.S. SPACE CAMP '89**, Box 1680, Huntsville, AL 35807, or call toll-free **1-800-63-SPACE**, in Alabama call **205-837-3400**.



YOU WILL FLY!

PACIFIC RIM SPACEFLIGHT ACADEMY



Experience 5 action-packed days this summer as an astronaut trainee in the most thrilling space camp imaginable!

For information, write or call:

OMSI

Oregon Museum of Science & Industry
4015 SW Canyon Rd. • Portland, OR 97221
(503) 222-2828

The Observatory

continued from page 10

the needed characteristics. For all our accomplishments, however, there are many problems still to be resolved. Cooperation with other space powers, and especially with the United States, which, as far as I know, is also actively involved in preparations for a flight to Mars, could be very beneficial for all sides.

It is known, for example, that the United States is planning a Martian expedition [by way of] the Moon. The USSR is prepared to offer its space systems for the lunar part of the project. Speaking of our Energia firm in particular, it could provide an Energia rocket, a booster module for the delivery of cargo and the crew from a near-Earth to a near-lunar orbit, elements of the lunar base, inflatable structures for residential and other premises, Moon cars, etc.

As for the Martian complex, in our opinion it could consist of three parts: a living module in which the crew will stay during the flight to Mars and back; a solar "tug" having a power unit with solar panels and electro-jet engines with a reserve of fuel; and finally, a descent module for landing on and taking off from Mars. The return of the crew from Earth orbit (where the expedition will arrive at its close) will be done with the facilities of the manned orbiter.

The sides could discuss the following possible work arrangement: The Soviet Union would be responsible for the living module and the United States for the descent module, while the solar tug would be designed by joint efforts.

But then, of course, the American side may have other ideas. We are prepared to discuss them. □



Baikonur

continued from page 49

by pushing a button on the handle in your right hand. The Soviet MMU worked as if the button were always pushed. As long as you pushed the handle, you kept going at a predetermined rate. When you let up on the handle, you stopped. This is a workable mode, but it seemed to require more gas for all the starting and stopping. I'd like to try it out in space to make a real comparison.

After about an hour in the suit, I depressurized and climbed out the door in the back. I changed into my clothes, signed my name on the wall alongside the other cosmonauts who had trained there, and we went upstairs for a formal debriefing. John Fabian wasn't able to try out the MMU because they didn't have a suit available that was large enough for him.

I tried to give the Soviet engineers an honest evaluation of their system from my brief experience. After lunch, we presented Guy Severin with our own MMU patch, to be sent aloft with the Soviet version on its launch late last fall. As John and I drove off to the airport, Severin promised to send a copy of the videotape of the test to us on our return. Sure enough, the tape arrived shortly after we got back.

Even since our return, communication and cooperation between astronauts and cosmonauts has been increasing at an ever faster rate. In February, four active U.S. astronauts went to Star City and Baikonur to watch a crew launched to Mir, and I wouldn't be surprised if a joint flight or crew exchange were announced soon. In the next few years, if the Soviet Union comes through its current restructuring with its space program intact, I expect to see a cosmonaut on the space shuttle and an astronaut on Mir. Space, which was once a symbol of the Cold War, could become a common ground where the superpowers can cooperate to explore the universe and extend mankind's reach beyond the Moon, into the Solar System. □

Pinky Nelson is a veteran of three space shuttle missions, including the STS-26 flight of Discovery in 1988. He left NASA in 1989 to join the astronomy faculty at the University of Washington.

Destinations

Without adventure, civilization is in full decay.

Alfred North Whitehead



TOM USCIAK

Make the 'right choice' and face the 21st century with confidence.



AT&T made the 'right choice' when they selected GE Astro's 7000 Series design for their new generation spacecraft, Telstar 4. Faced with an increased demand for domestic and international traffic, today's space communications system owners can also make the right choice to fulfill their particular requirements.

Astro's space-proven design inventory provides a range of weight classes that can accommodate very focussed or very complex missions. Our communications satellites have an enhanced payload and bus technology base which provides customers with longer life, higher performance and increased capacity systems.

Join the likes of AT&T, NEC, GTE, and INTELSAT and choose GE Astro. You'll enter the 90s with confidence in having made the right choice; the choice that offers you the best value and most reliable performance in communications satellites.

GE Astro Space

TELSTAR 4 for AT&T



Only an educated America can promise our country a future in space.

With space providing inspiration, and education providing opportunity, our children will have what they need to make their mark on history.

MCDONNELL DOUGLAS

